MONTHLY WEATHER REVIEW.

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The MONTHLY WEATHER REVIEW summarizes the current manuscript data received from about 3,500 land stations in the United States and about 1,250 ocean vessels; it also gives the general results of the study of daily weather maps based on telegrams or cablegrams from about 200 North American and 40 European, Asiatic, and oceanic stations.

The hearty interest shown by all observers and correspondents is gratefully recognized.

Acknowledgment is also made of the specific cooperation of the following chiefs of independent, local, or governmental services: R. F. Stupart, Esq., Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Señor Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt. S. I. Kimball, General Superintendent of the United States Life-Saving Service; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; Dr. W. N. Shaw, Director of the Meteorological Office, London; Maxwell Hall, Esq., Government Meteorologist, Kingston, Jamaica; Rev. L. Gangoiti, Director of the Meteorological Observatory of Belen College, Havana, Cuba; Señor Luis G. y Carbonell, Director, Meteorological Service of Cuba, Havana, Cuba; Rev. José Algué, S. J., Director of the Phillipine Weather Bureau, Manila; Maj. Gen. M. A. Rykachef, Director of the Physical Central Observatory, St. Petersburg, Russia; Carl Ryder, Director, Danish Meteorological Institute, Copenhagen, Denmark.

As far as practicable the time of the seventy-fifth meridian is used in the text of the MONTHLY WEATHER REVIEW.

Barometric pressures, both at land stations and on ocean vessels, whether station pressures or sea-level pressures, are reduced, or assumed to be reduced, to standard gravity, as well as corrected for all instrumental peculiarities, so that they express pressure in the standard international system of measures, namely, by the height of an equivalent column of mercury at 32° Fahrenheit, under the standard force, i. e., apparent gravity at sea-level and latitude 45°.

FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

An abnormal distribution of atmospheric pressure is invariably associated with marked departures from seasonal weather. During the past winter pressure was abnormally low over the northern Pacific and thence over and near the boundary between the United States and British America and was unusually high over the southern Pacific and southwestern portions of the United States. This arrangement of pressure caused a prevalence of mild southerly winds over the United States and drew over the extreme British Northwest Territory exceptionally cold winds from the Far North. At times there were reversals of this pressure distribution and cold air masses swept southward over the United States. A notable instance of this kind occurred during the first decade of January, when from North Dakota to Washington and northern Oregon the cold exceeded any previous record for the same period. The fact that the reversals of prevailing pressure conditions, with subsequent cold-wave visitations, were in each instance foreseen, furnishes additional evidence of the value of pressure charts that permit a daily survey of the oscillations and movements of the great centers of action of the Northern Hemisphere. By the aid of these charts the cold-wave warnings of the past winter were exceptionally accurate, and they were for the first time successfully made for periods of several days in advance.

The first important storm of March, 1909, moved from the Northwest rapidly southeastward to the middle Atlantic coast during the 2d and 3d, where it deepened rapidly and turned sharply northward near and off the coast during the night of the 3d, attended over the Atlantic States north of Virginia by rain or snow and high north to northwest winds. Until the passage of its center over the Atlantic coast line this storm possessed moderate strength only. The abnormal checking of its eastward progress and its subsequent increase in intensity and sharp recurve to the northward were due to conditions that existed over the ocean beyond the region of observation. The usual features that attend the continental class of storms to which this storm belonged were forecast, and warnings of the gales that swept the Atlantic coast the night of the 3d and during the 4th were issued the morning of the 3d. The rain, snow, and high winds of the night of the 3d and morning of the 4th prostrated electric wires and seriously interfered with communication and transportation in the Middle Atlantic States.

During the week ending Saturday, March 13, an extensive area of precipitation covered the country from British America to the Mexican border and the Gulf of Mexico. In the North, West, and Southwest the precipitation was in the form of snow, and in the middle and east Gulf States and Georgia heavy rains caused flood stages in streams. Following the precipitation, the weather was exceptionally cold in the middle and southern Rocky Mountain districts, and on the morning of the 13th minimum readings of 2° and 24° were reported at Roswell, N. Mex., and El Paso, Tex., respectively. During the succeeding two days frost-producing temperatures extended eastward over the Gulf and South Atlantic States.

The following special forecast was issued Sunday, March 14:

During the present week a disturbance will advance from the Pacific to the Atlantic coasts from about Tuesday to Friday, preceded and attended by rising temperature and by general rains in middle and southern districts and by snow in the more northern States, and followed by a period of cooler, fair weather that will set in over the Northwestern States Tuesday night and reach the Atlantic seaboard about the close of the week.

The disturbance referred to appeared Tuesday, the 16th, over the Pacific States, and its center reached the Atlantic coast Friday night, the 19th. Its passage was attended by snow from the Missouri Valley over the Southern and Southeastern States. It was followed by lower temperature that set in over the Northwest Tuesday night and reached the Atlantic and east Gulf States Saturday.

On the 20th heavy rain set in over California. During the succeeding three days the rain area extended over the Middle, Western, and Southwestern States, with heavy snow in the middle Rocky Mountain districts. On the 24th the rains extended over the central valleys, Lake region, and Atlantic

States. During the 25th and 26th pressure was very low over the Atlantic States, with minimum readings about 28.90 inches from northern Virginia to southern New England on the 25th. Following this depression snow fell as far south as eastern Tennessee, and frost occurred the morning of the 26th in the middle and east Gulf and South Atlantic States. During the closing days of March kite flights at Mount Weather, Va., showed unusually low temperatures at an altitude of about 1 mile. On the 30th the temperature gradient to that height was 26° and on the 31st it was 22°, the average gradient being about 15°. The presistent cloudiness of this period in the Middle Atlantic States may be attributed to the unusually low temperature of the upper air that overlaid that region.

BOSTON FORECAST DISTRICT.*

[New England.]

The weather, generally speaking, was that of the average March. Snowfall was heavy in northern and moderate to light over other portions of the district. At the close of the month snow was 3 or 4 feet deep in the woods and mountains of the northern sections. The only severe storm was that of the 25–26th during which gales of great force swept the entire coast. During the storm a number of schooners and smaller craft were driven ashore, and some damage was caused to shore property. Warnings were issued well in advance of the gale and were of great benefit. Relative to the warnings the Boston Herald remarked as follows: "The storm warnings signaled from Cape Hatteras to Eastport saved many skippers from the gales which piled up the roughest sea that has run on the Atlantic coast in many years."

There were no storms during the month without warnings.—*J. W. Smith, District Forecaster.*

NEW ORLEANS FORECAST DISTRICT.*

[Louisiana, Texas, Oklahoma, and Arkansas.]

There was an excess in temperature and a deficiency in precipitation throughout the greater part of the district. Warnings were issued for all severe weather conditions that occurred during the month.—*I. M. Cline, District Forecaster.*

LOUISVILLE FORECAST DISTRICT.*

[Kentucky and Tennessee.]

Temperature and precipitation averaged about normal. The coldest weather occurred about the middle of the month, and the principal rain periods were the 5–6th and 8–9th when there was considerable flooding in the streams and over the lowlands.—*F. J. Walz, District Forecaster.*

CHICAGO FORECAST DISTRICT.*

[Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, and Montana.]

There were no unusual weather features in the district during the month. No cold-wave warnings were issued and no severe gales occurred on Lake Michigan.—*H. J. Cox, Professor and District Forecaster.*

DENVER FORECAST DISTRICT.*

[Wyoming, Colorado, Utah, New Mexico, and Arizona.]

The lowest temperatures of the month were recorded from the 8th to 15th. In southeastern Wyoming and in the north-central counties of Colorada the snowfall of the month was unusually heavy.—*P. McDonough, Local Forecaster.*

SAN FRANCISCO FORECAST DISTRICT.†

[California and Nevada.]

The month was in most respects a typical March month. The number of barometric disturbances was below the average. In the central portion of California the average number of rainy days was thirteen, or three days more than normal. No frost warnings were issued.—*Alexander G. McAdie, Professor of Meteorology.*

PORTLAND, OREG., FORECAST DISTRICT.†

[Oregon, Washington, and Idaho.]

Although stormy weather prevailed during the opening and closing days the month on the whole was unusually quiet. Precipitation was below and temperature slightly above normal. There were many frosty mornings, but no cold spells worthy of note. Snow in the mountains at the end of the month was deeper than usual, while that on the southern slopes thawed so slowly that none of the rivers reached a flood stage.—*E. A. Beals, District Forecaster.*

RIVERS AND FLOODS.

At the end of February, 1909, the Ohio River was above flood stage from Maysville, Ky., to the mouth of the Tennesee River, with the crest of the flood nearing Evansville, Ind. The flood stage of 45 feet was reached at Cairo, Ill., on March 2, and from that day until March 22, inclusive, the river remained above the flood stage below the mouth of the Tennessee River. The crest stage of 47.3 feet was reached at Cairo on the 17th. In the lower Mississippi River flood crests and dates thereof were as follows:

Station.	Crest stage.	Flood stage.	Date.
	Feet.	*Feet.*	
New Madrid, Mo	38.6	34	March 18
Memphis, Tenn	38.6	33	March 22
Helena, Ark	47.7	42	March 25
Arkansas City, Ark	50.1	42	March 28–30
Greenville, Miss	44.8	42	March 29, 30
Vicksburg, Miss	48.1	45	April 2, 3
New Orleans, La	17.9	18	April 3

Owing to the excellent condition of the levees, and to the warning given to remove property, etc., from unprotected land, the Mississippi flood passed off without unusual incident, and almost entirely without losses or damage. The flood was a rapid one and in the Memphis district there was very little delay in farm work. The completion of the levee in front of Reelfoot Basin, Tenn., has disturbed the gage relations previously existing at all places between Cairo and Memphis, and the following interesting statement on the subject was prepared by Mr. S. C. Emery, Official in charge, Local Office of the Weather Bureau at Memphis, Tenn.

* * * * * * *

As this was the first high water that has occurred since the completion of the levee in front of the Reelfoot Basin, it is of special interest to note its effect on gages below Cairo, Ill. Heretofore, whenever the river at Cairo reached a stage of 38 feet, or 29 feet at New Madrid, Mo., the water began to flow out to the Reelfoot Basin, in which, during flood periods, a large amount of water was stored. In this way a considerable portion of the water passing Cairo did not reach New Madrid, but passed around that point and a portion reentered the Mississippi several miles below New Madrid near Fulton, Tenn. Since 1907 a levee has been constructed from near Hickman, Ky., to the high bluffs above Tiptonville, Tenn., its purpose being to keep the Mississippi water in flood time from flowing over the low banks in that section into the Reelfoot district. By forcing the water to pass New Madrid the flood plane at that place has been increased about 2½ feet, that is, instead of a difference between Cairo and New Madrid of 11 feet as shown during former periods of high water, it is now seen that this difference has been reduced to less than 9 feet and in extreme high water the difference is expected to be still less. The effect of closing the Reelfoot Basin appears also to have raised the flood plane at Memphis, Tenn. In former years the difference in the gages at Cairo and Memphis has been 10 feet or more. In 1907 when the extreme stage was 40.3 feet the difference in crest stages at Cairo and Memphis was 10.6 feet, while in the present rise the difference is only 8.7 feet and it seems probable that when higher levels are reached this difference will be close to 8 feet. At Helena, Ark., there seems to be little or no change in the gage relation with either Cairo or Memphis, the difference still being approximately 10 feet.

Along the lower Ohio River conditions were not so favorable. Bottom lands were overflowed for a considerable period of time and much inconvenience resulted, especially to those who were driven from their homes, but the actual damage was small.

There were moderate floods in the White River of Arkansas at various times from March 8 to 22, inclusive, for which

* Morning forecasts made at district center, night forecasts made at Washington, D. C.

† Morning and night forecasts made at district center.

warnings were issued at the proper time. Some inconvenience resulted, but the damage was insignificant.

Heavy rains at various times from the 9th to the 13th, inclusive, over Georgia and Alabama were followed by general floods in those States. The floods in Georgia, however, were not serious, although flood stages were general over the central and western portions of the State. Conditions were probably most pronounced along the Chattahoochee River where considerable damage of the usual character was done. At Columbus mills were obliged to close.

In the State of Alabama the rains were much heavier than in Georgia, and conditions much more serious. Warnings were first issued over the Alabama watershed on the 10th, with supplementary warnings on the 11th and 12th that the floods would be the highest of recent years, probably passing the 50-foot stage in the Alabama and extreme lower Coosa rivers.

Five lives were lost at Montgomery, and property along the river to the value of $450,000. It is estimated that the losses in live stock alone amounted to $200,000. The value of the property saved by the warnings about equaled the losses, although more of the latter may yet be reported, as several thousands of acres of oats were under water and may have been killed.

The warnings were of the greatest benefit to all classes, and those who were in a proper position to appreciate their value, have made frequent acknowledgment of the same.

The flood in the Black Warrior and lower Tombigbee rivers was as pronounced as that in the Alabama River, but the losses were trifling as a whole. The high waters were a distinct benefit to the lumber interests as they permitted the movement of logs to the value of $200,000. The value of the property saved through the Weather Bureau warnings was above $200,000, representing principally cattle and lumber in the lowlands.

The crest and flood stages in the Alabama, Black Warrior, and Tombigbee rivers were as follows:

Station.	Crest stage.	Flood stage.
	Feet.	*Feet.*
Montgomery, Ala.	51.7	35
Selma, Ala.	52.9	35
Tuscaloosa, Ala.	61.3	43
Demopolis, Ala.	61.5	35

The flood in the Pascagoula watershed of Mississippi was much more moderate, and the total losses did not exceed $15,000. The value of property saved by the warnings was also about $15,000.

Nothing of special interest occurred on other rivers.

ICE.

The Missouri River at Pierre, S. Dak., opened at 4 p. m. of the 6th, and after that date practically the entire river was open. The Red River of the North opened at Moorhead, Minn., on the 18th.

The Mississippi River remained frozen throughout the month at Fort Ripley, Minn. The ice moved out at St. Paul, Minn., on the 15th, at Red Wing, Minn., on the 23d, and at La Crosse, Wis., on the 31st. The river remained closed at Prarie du Chien, Wis., but at Dubuque, Iowa, it opened on the 21st. Farther down the river was open, although floating ice was observed at Le Claire, Iowa, as late as the 19th.

The rivers of Maine remain frozen, but the Connecticut opened at Bellows Falls, Vt., on the 11th and at Whiteriver Junction, Vt., on the 26th, remaining closed above the latter place.

The highest and lowest water, mean stage, and monthly range at 204 river stations are given in Table VI. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

A CHRONOLOGICAL OUTLINE OF THE HISTORY OF METEOROLOGY IN THE UNITED STATES OF NORTH AMERICA.

This outline of the history of meteorology in the United States of North America has been prepared to meet a somewhat general demand for the information it contains. The contents represent the combined judgments of the members of the Washington staff of the United States Weather Bureau, and the Editor wishes to acknowledge the generous cooperation of all his colleagues.

While the choice of events to be regarded as important milestones in the history of the science of meteorology must be in part a matter of individual judgment, it is nevertheless possible to be uniformly correct in the facts stated and the dates given. This compilation aims at this ideal. It is hoped that at a later date this historical chronology of the science of meteorology may be supplemented by a chronological list of the more important meteorological phenomena of North America.—*C. A.*

1644–45. As far as known the first regular record of the weather on the American Continent was kept by the Rev. John Campanius at the Swedes' Fort, near Wilmington, Del.

1723. Prof. Isaac Greenwood, of Harvard College, recommended to the Royal Society of London a form for marine meteorological records.

1727–1738. First course of lectures on meteorology at Harvard College, by Prof. Isaac Greenwood.

1729–30. A regular weather record was kept at Boston, Mass., by Hon. Paul Dudley, Chief Justice of Massachusetts.

1730. Dr. John Lining began thermometer records at Charleston, S. C., using a Fahrenheit thermometer made in England and standardized there.

1738–1750. Regular meteorological observations were made at Charleston, S. C., by Dr. John Lining. These included Fahrenheit and other thermometers, the barometer, and the hygroscope.

1739. Benjamin Franklin (*b.* January 17, 1706, *d.* April 17, 1790) on his homeward voyage from England kept records of the weather and water temperatures, using an English Fahrenheit thermometer, and suggested a method of determining the approach of vessels to the American coast by the temperature of the water.

1739–1765. A regular course of lectures on meteorology delivered annually at Harvard College by Prof. John Winthrop.

1742–1778. Regular meteorological records were kept at Cambridge, Mass., by Prof. John Winthrop of Harvard College. He used a Hawksbee thermometer until 1763 and then a Fahrenheit.

1743. In September Benjamin Franklin, then Postmaster General, from the reports of numerous postmasters and from the fact that at Philadelphia, Pa., a storm prevented observations of an eclipse of the moon, while at Boston, Mass., the eclipse was over an hour before the storm began, deduced the progressive movement of a hurricane storm moving up from the West Indies. This is the first recorded instance in which the progressive movement of our storms as a whole was recognized.

1747. Publication at Philadelphia, Pa., of Lewis Evans's map, containing Franklin's rule "that all great storms begin

to the leeward," as did the storm observed in September, 1743.

1748. Meteorological records were kept by John Bertram at his botanic garden on the Schuylkill, near Philadelphia, Pa.

1749. November 9, Benjamin Franklin proposed to use pointed rods to draw down lightning.

1750. In the spring Franklin flew his electric kite with pointed wires, at Philadelphia, Pa.

1750–1759. Doctor Chalmers, at Charleston, S. C., continued the record begun by Doctor Lining.

1752–1765. Regular records of daily maximum and minimum temperatures by Prof. John Winthrop at Cambridge, Mass.

1752. Benjamin Franklin's letter to the Royal Society of London on lightning and electricity.

1753–1755. Meteorological records kept by Dr. Richard Brooke near Baltimore, Md.

1760–1762. Francis Fauquier, Lieutenant Governor of Virginia, kept a meteorological record at Williamsburg, Va.

1770. Dr. Hugh Williamson published "An attempt to account for the change of climate which had been observed."

1772–1777. Thomas Jefferson at Monticello, Va., and James Madison at Williamsburg, Va., maintained a series of contemporaneous observations and showed that the climatic peculiarities of those two places harmonize completely.

1780–1790. Prof. Samuel Williams at Harvard College continued the records formerly kept by Prof. John Winthrop; collected all available observations on the extreme temperatures experienced in eastern Massachusetts between 1752 and 1786; delivered excellent lectures on climatology; made a series of studies of the amount of evaporation.

1781. The Meteorological Society of the Palatinate at Mannheim began the publication of its "Ephemerides," which contained daily records from all accessible observers, including four from the United States, viz, Charleston, S. C., Philadelphia, Pa., New York, N. Y., and Cambridge, Mass.; the object being to search out or discover broad relations that might serve for long-range forecasts. These records were utilized by Brandes in 1825 to show that storms must be treated as entities moving over the surface of the earth.

1783. June 5, Benjamin Franklin describes the hot-air balloon sent up by Pilatre from Champs Elysees.

1783. Rittenhouse of Philadelphia, Pa., sends up hydrogen balloons simultaneously with European experiments.

1784. In May Benjamin Franklin while in Paris, after studying the influence of the great haze that spread over Europe from the eruption in 1703 of Kaptar Jokul in Iceland, announced his theory and his prediction or expectation of a cold winter.

1785. Benjamin Franklin appears to have again made a similar long-range prediction as to the coming winter in New England.

1789. Beginning of regular records of the freezing of the Hudson River at Albany, N. Y.

1790–1807. Prof. Samuel Webber kept the meteorological record at Harvard College.

1799–1806. Publication of a memoir by Doctor Webster "On the supposed change of the temperature of winter."

1800–1806. Prof. John Farrar at Cambridge, Mass., kept a record of meteorological observations with a "Daniell's hygrometer."

1806. Hon. Simeon DeWitt, of Albany, N. Y., read a memoir on "Climate in its Relation to Agriculture" before the American Agricultural Society in New York, N. Y.

1807–1817. Prof. John Farrar maintained a full weather record at Cambridge, Mass.

1807–1836. Prof. John Farrar annually delivers his "Lectures on the Atmosphere" as part of his duties as Hollis Professor at Harvard College.

1807. Hon. Simeon DeWitt read a paper before the Albany Institute describing his conical rain gage; in May, 1832, he described a similar and cheaper 9-inch conical gage, the use of which was wide spread at that time.

1812. On August 11 of this year Samuel Rodman began his meteorological record at New Bedford, Mass., which is still maintained by his descendants. It constitutes the longest continuous record in the United States.

1817. Josiah Meigs, Commissioner of the General Land Office, issued a circular dated April 29, in which he solicited meteorological records and phenological observations by the registrars of the respective land offices.

1819. The Surgeon General of the Army established a system of meteorological records at U. S. Army posts.

1819–1823. U. S. Army Topographical Engineers maintain meteorological records at the "Cantonment," 3 miles southeast of Council Bluffs, Iowa.

1820. James P. Espy (*b.* 1785, *d.* 1860) left his position in the Academy in Cumberland, Md., becoming Professor of Languages at the Franklin Institute in Philadelphia, Pa., and began his life-long work in meteorology.

1821. William C. Redfield discovered the rotation and progression of hurricanes.

1822. James P. Espy stated that he always observed the moisture of the atmosphere by means of the whirled wet-bulb or sling psychrometer. After having first made a number of comparative experiments with the dew-point apparatus, he found in general that the dew-point is as far below the temperature of the wet-bulb as that is below the dry-bulb.

1824. Beginning of the weather record at the Pennsylvania State Hospital, Philadelphia, Pa., which is continuous to the present date.

1825. The regents of the University of the State of New York established a system of meteorological records at the academies under their control.

1830. James P. Espy announced the cooling of ascending air by expansion. About this time Espy resigned from all his work as teacher and devoted himself to lecturing on meteorology.

1831. W. C. Redfield published the first of a long series of memoirs of importance on hurricanes as great revolving storms.

1835. July 2, first balloon ascension by John Wise at Philadelphia, Pa

1835–1840. Franklin Kite Club organized and conducted kite work in Philadelphia, Pa.

1836. Espy awarded the Magellanic Premium by the American Philosophical Society for his work in meteorology.

1836. Espy secured the appointment, by the American Philosophical Society and the Franklin Institute, of a joint committee for the study of storms.

1836. Nicollet prepared instructions for the use of the meteorological observers of the Surgeon General's Office.

1836. Elias Loomis compiled his memoir on "The Storm of 1836," the first of a long series of important memoirs. He also compiled instructions for taking meteorological observations for the use of the Surgeon General of the Army.

1837–1845. The Franklin Institute and the State of Pennsylvania cooperate in the establishment of meteorological stations in each county of the State.

1838. The first special appropriation in this country, of public money for the collection of weather information; the legislature of Pennsylvania made a grant of $4,000 to the Franklin Institute.

1838. Espy devised his first "nepheloscope" to show the formation of cloud or fog by sudden expansion of air, but found that the formation of cloud within the apparatus becomes more difficult with each successive expansion. He attributed this result to the washing out of the dust particles contained in the experimental air, thus in part anticipating the work of Aitken and Townsend in recent years.

1838. Establishment of the meteorological and magnetic observatory at Toronto, Canada.

1838–1842. U. S. Exploring Expedition to the Pacific Ocean under Commander Charles Wilkes, U. S. Navy. Its meteorological work is yet only partially published.

1838–1860. Lieut. M. F. Maury (*b.* 1806, *d.* 1873), Superintendent of the U. S. Naval Observatory, collected ships' logs; compiled and published sailing charts; wrote his work, "The Physical Geography of the Sea."

1838. James H. Coffin, while principal of the Academy at Ogdensburg, N. Y., began the publication of his monthly, "The Meteorological Reporter" which included the records for 1836–1838 made by his self-recording wind integrator which gave the number of hours that each direction of the wind prevailed during those years on the top of the mountain, Greylock, near Williamstown, Mass.

1840. August and September, Espy appeared before the British Association for the Advancement of Science at Glasgow, and the Academy of Sciences at Paris, to expound and defend his ideas as to the theory and cause of storms. A committee of the Paris Academy of Sciences reported favorably on Espy's theory of storms.

1840. Establishment by A. D. Bache (*b.* 1806, *d.* 1867), of the Meteorological and Magnetic Observatory of Girard College, Philadelphia Pa., where hourly observations of temperature and dew-point were made up to 1845.

1840–1850. Discussions between Bache, Henry, Hare, Johnson, Olmstead, and others, both in scientific magazines and newspapers, as to the character of our tornadic and other storms, and the nature of the forces involved therein.

1841. James P. Espy published his work on the "Law of Storms" maintaining the importance of the expansion of the rising air in the formation of thunderstorms, and explaining the special cloud formation known as "The Helm and Bar" in England, and the foehn-phenomena or the warmth of descending air. He also explained the diurnal variation in the wind force and direction; the dryness of descending air near cumulus clouds; the reason why an ascending current produced by a local conflagration might be expected to bring cloud and rain; the reason why some clouds are seen to be melting away and disappearing while others are growing larger and heavier.

1841. Loomis (*b.* 1811, *d.* 1889), published his map and study of the storm of December, 1836, in the Transactions of the American Philosophical Society at Philadelphia, Pa.

1842. Espy appointed "Meteorologist to the U. S. Government" by Congress and assigned to duty under the Surgeon General of the Army, and was so employed from August 26, 1842, to June 30, 1847.

1843. Prof. Dr. Robert Hare (*b.* 1781, *d.* 1858), opposes Espy and others and defends the idea that electricity is the important force in our storms.

1843. Charles Tracy published his memoir on the rotary movement of a storm. He concluded that this movement necessitates searching for a stable source of momentum and showed that the rotation of a storm is the effect of the earth's diurnal rotation, but did not arrive at the full measure of this influence.

1843. October, date of Espy's first meteorological report addressed to the Surgeon General of the Army.

1844. November, completion of the first line of Morse telegraph, between Washington and Baltimore. It was thrown open to the public April 1, 1845, and from this date onward, according to the testimony of old telegraphers, it was customary among the operators to advise each other of local weather by watching and predicting the movement of weather changes.

1847. Establishment by James Green of his workshop for the manufacture of the highest grade thermometers and barometers for the use of the Smithsonian Institution, the Surgeon General, the Army Engineers, and all other meteorological observers.

1847. December 8, Joseph Henry submitted his program of Organization and Work for the Smithsonian Institution, including first of all "A system of extended meteorological observations for solving the problem of American storms." The Smithsonian Institution continued after this date a prominent factor in the development of meteorology in the United States.

1847. Espy and Loomis addressed letters to Prof. Joseph Henry, as Secretary of the Smithsonian Institution, urging the importance of the establishment of meteorological stations and reports for the study of American storms.

1848. August 10, Espy appointed to meteorological work under the Secretary of the Navy and ordered to work in cooperation with the Secretary of the Smithsonian Institution where he prepared the first circulars of the Smithsonian Institution relative to securing meteorological observers.

1848. James Glaisher started daily weather reports for publication in the London Telegraph, and corresponded with the Smithsonian Institution as to similar work in America.

1848. J. Jones, of New York, N. Y., announced his intention of preparing weather maps and forecasts in New York City if properly supported financially, but the enterprise seems to have gone no further.

1849. November, date of Espy's second Meteorological Report (addressed to the Secretary of the Navy).

1850. Professor Guyot compiled the first edition of the Smithsonian Instructions for Meteorological Observers. (Published in 1852.)

1850. October, date of Espy's third Meteorological Report, (addressed to the Secretary of the Navy) with notes dated October, 1851.

[*To be continued.*]

WEATHER BUREAU KIOSKS.

By D. T. MARING, Instrument Division. Dated February 13, 1909.

In nearly all the large cities of the country at which regular, telegraphic-reporting stations of the Weather Bureau are established, the records from automatic instruments and the meteorological data recorded, as well as the daily observations and forecasts that are made, are always open for the benefit of the public, but, unfortunately, the modern development and construction of large and lofty buildings have necessitated the placing therein of the local offices and the exposure of the instruments on their high and comparatively inaccessible roofs. While such offices and instrumental records are, of course, still readily accessible to the public by means of rapidly-moving elevators, and information is easily procurable by universal telephone, yet, the great height of the instruments above the ground, which must be thus exposed for general forecast and climatological purposes, does not give the surface conditions in which the great mass of people move. For these reasons, therefore, there has been a growing demand for more accurate and reliable meteorological records nearer the ground, especially for temperatures, which the public has generally had to obtain as best it could from cheap and inferior thermometers improperly exposed in front of stores and shops.

With a view to meeting this demand in a practicable manner the Chief of the Weather Bureau directed that a suitable structure be designed for installation on street sidewalks, or within public parks, and, under the personal supervision of Prof. Chas. F. Marvin, in charge of the Instrument Division, the shelter shown in the accompanying illustration has been developed.

The name "Kiosk" was selected for this structure as being short and expressive, it being that employed in foreign countries for street shelters and bulletin boards used for a similar purpose. The designs of the foreign kiosks were, however, not found to be suitable to the demands in this country, and

several local architects and artists were, therefore, requested to submit competitive plans and sketches. From among these one was selected as best adapted to the special needs of the Weather Bureau. This was perfected along the lines of a four-sided structure about 4 feet square and 7 feet high; with a recessed space on each face 30 inches wide, 35 inches high and 5 inches deep, for the display of instruments, charts, maps, etc., of general meteorological interest; each space being covered by a plate-glass window sash counterbalanced by weights in the corners so as to be easily raised and lowered within the framework itself. The interior was made especially open and free, so that the bulbs and actuating parts of the instruments could be projected therein, where they would be protected from injury, be as completely screened as possible from radiation effects, and yet at the same time, given perfect ventilation to the air. By conventional architectural designs the exterior surfaces were given a pleasing artistic appearance, so that the kiosk as a whole should harmonize with public buildings or other structures near which it might be installed.

FIG. 1.—General view of kiosk as installed at Washington, D. C. North side, showing instruments in position.

When the plans had advanced sufficiently, they were placed in the hands of a manufacturer familiar with the construction of ornamental iron structures, and arrangements made to have the kiosk built of thin, cast-iron plates, as being the cheapest and most durable material available. The work has been carried out in a very satisfactory manner. When the kiosk is erected on a solid stone or concrete foundation, to which it is securely attached, similar to that shown in the illustration, and kept nicely painted in some light neutral tint to harmonize with surroundings, certain parts being gilded for decorative effects, it forms, as a whole, a neat and substantial structure that should last indefinitely.

Three sides of the kiosk are provided in the recesses with neatly framed wooden bulletin boards, having spring clips that may be arranged in any suitable manner to properly hold, for display, climatic charts, bulletins, daily weather maps, forecasts, etc., or data of special local interest.

Instruments.—The selection and arrangement of the instruments required most careful consideration. As there was nothing on the market entirely suitable for such display as this, it was necessary to perfect the details of each instrument to meet the special needs, and several of the most prominent manufacturers of meteorological apparatus in this country were called upon to carry to perfection the plans and specifications given them in their certain lines. The instrumental equipment, as now provided for, consists of the following:

(1) *Hygrometer.*—A simple form of indicating hair hygrometer, with scale of percentages for relative humidity.

(2) *Thermometer.*—A plain mercurial thermemeter, of large size (Fahrenheit); accurately stem graduated, with conspicuous figures and markings to facilitate easy reading.

(3) *Maximum and minimum thermometers.*—Indicating, self-registering; Fahrenheit scale, stem graduated; of the vertical, Six type; having steel indexes to be set by permanent magnet.

(4) *Raingage.*—This is of the tipping-bucket pattern, with dial mechanism indicating hundreths of an inch and inches of precipitaion as caught in the central top of the kiosk, which forms the receiver of the gage proper, is made of copper, and is 15 inches square.

(5) *Thermograph.*—A form of mechanically recording thermometer, making a continuous and automatic record of the temperature (Fahrenheit), on a two-week sheet of band form, so arranged that the previous record for several days from date is in plain view.

Fig. 2 shows diagrammatically the manner in which these instruments are mounted within the kiosk to secure the best effects and exposures, and, at the same time permit of the most critical inspection of the records and indications made.

As shown in the illustration, fig. 1, the thermograph record sheets may also be displayed just above the instrument, under spring clips at the ends, so that the temperatures for the preceeding two weeks are also available for consultation. Records for the corresponding period of the previous year would form an interesting addition to this part of the exhibit.

Other forms of instruments may be furnished in the future, in addition to those mentioned above, if there is a demand for them, but it is obviously impracticable to attach such registering instruments as those for recording wind direction or velocity, for example, owing to the restricted exposures in which the kiosks must ordinarily be placed.

Suitable printed labels, giving in a concise manner, brief explanations and descriptions, in the simplest possible language, are attached to each instrument, etc., so that its operation and the results secured may be understood by anyone.

While the records obtainable from this apparatus, as a whole, exposed at the ground on city streets within a location more or less entirely inclosed by high office buildings, can not, of course, have special meteorological value, and can not well be used for climatological purposes, they may still, at times,

serve as a check on the records of the standard instruments of the Service properly exposed. The kiosk records should also prove useful to the local press, and, as giving actual *street* weather conditions, they should be of considerable utility and of more than passing interest and convenience to the general public.

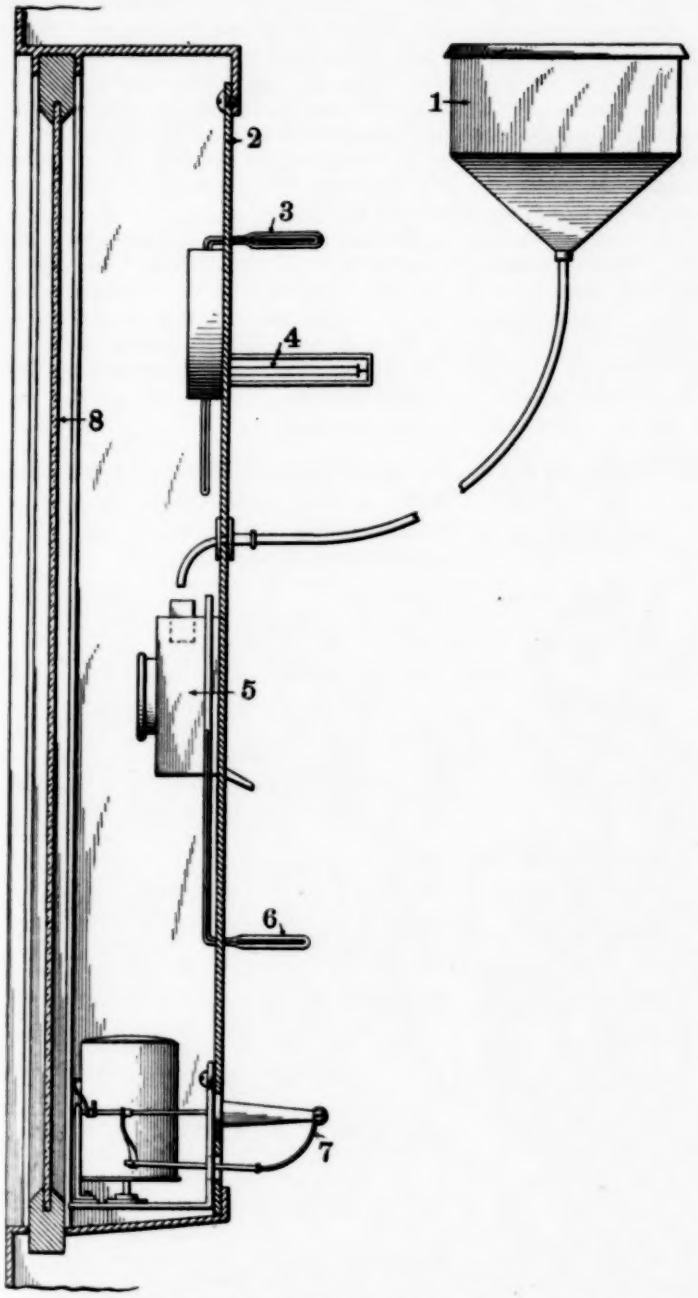

FIG. 2.—Arrangement of instruments in kiosk. Side view. 1. Rain-gage receiver. 2. Iron back plate. 3. Bulb of the Six maximum-minimum thermometer. 4. Frame and hairs of hygrometer. 5. Tipping-bucket dial indicator. 6. Bulb of exposed thermometer. 7. Thermograph bulb. 8. Plate glass in sash.

SUGGESTED REFORMS IN METEOROLOGICAL METHODS.[1]

By M. E. J. GHEURY, F. R. A. S. Dated Eltham, Eng., March 4, 1909.

I understand that discussion is invited concerning Professor McAdie's suggested reforms in meteorological methods. Being a strong supporter of the metric system I would heartily support any reform that would bring this system into use: but, however, in this case, a very careful consideration of meteorological requirements, apart from others, should be undertaken before introducing any special modifications in the present methods of obtaining data as to the various climatologic factors. With this in view I beg to point out a few facts.

Thermometer scales.

While the centigrade scale of temperature is more rational than the Fahrenheit scale, the latter has the advantage that the magnitude of the degree of temperature is small enough to avoid subdivisions for ordinary meteorological purposes, where a greater exactitude suggested by the use of a decimal division of the degree is, to a certain extent, illusory. Decimals can therefore be dropped; and this, together with the fact that the negative sign is only needed in exceptional circumstances or regions, tends to give tabulated temperature data a simplicity which is lacking in similar tables involving the use of the centigrade scale, the magnitude of the degree on the latter being too great not to require subdivisions of some kind (and the most convenient is certainly the decimal).

When such a competent authority as M. G. Eiffel states as desirable the alteration of the centigrade scale so as to have 100° at melting ice and 200° at boiling point, with binary subdivisions, giving therefore almost exactly the degree Fahrenheit as unit and a similar graduation, it would be rash to throw overboard a scale of temperature which has the very advantages found lacking in the rival scale, besides that of being familiar to many. The beautifully simple rule given in the MONTHLY WEATHER REVIEW for 1907, p. 438, which does away with the doubt whether one must or must not add or subtract 32, enables reductions to be performed with such a rapidity and ease as to make the labor of conversion negligible.

Barometer scales.

As to Professor McAdie's proposal to take 760 millimeters as 1,000, the *normal* atmospheric pressure, and to express the height of the barometer as a percentage of this normal pressure, the obvious objection is that this normal pressure is only approximate, and may be altered when a more extensive study of the pressure over the whole globe shall be made. As a matter of fact each place has its own mean barometric pressure, and to adopt as standard a general normal pressure may be very misleading. Professor McAdie has evidently overlooked the existence of regions of *permanent* high and low pressures on the globe, for which such a notation would be very objectionable since it is based on an average barometric height which may be, for such a region, quite abnormal instead of normal.

I remember that in 1897, being south of Cape Horn, with an exceedingly low glass, we remained hove to for three days, waiting for a gale that never came. Had the pressure been expressed by 976, say, or 24 below normal, our captain would have had an excellent excuse for what was otherwise misplaced caution, as the weather was beautiful and my isobaric chart for the season showed that the low pressure was but slightly below the normal.

Moreover, we not only can not say for certain that the average barometric pressure taken all over the globe is 760 millimeters, but we can not say that it is constant and that it has been always at that point or will remain always so. We would have, by taking 760 millimeters, this very great evil of a fluctuating datum mark in our scale of barometric pressure.

The general public, in my opinion, if it does not realize the exact physical meaning of the barometric height, knows pretty well the general inference to draw from a rise or fall. I have had often to answer the inquiries of cultivators (who could have hardly made a correct inquiry by writing!) as to the behavior of my barometer during hay-making time. This, I consider, is a far more important notion, since we know that an

[1] See Monthly Weather Review, November, 1908, 36:372-374.

isolated barometric observation, whether above or below the normal, *has no value whatever* and becomes useful only when taken in reference to others.

As a last and quite secondary remark, may I point out that the example of reduction of wind velocity selected by Professor McAdie could not be more unfortunately chosen. Every one who has to deal with velocities of that order knows that 60 miles per hour is equivalent to 88 feet per second, and it does not require any time or labor to see that 6 miles per hour is 8.8 feet per second. I am no expert and very poor at mental arithmetic, yet I can, in the twinkling of an eye, reduce the decimal to inches and decimals without pencil and paper, since (to illustrate the mental process followed),

$$\frac{8}{10} \text{ feet} = \frac{8\times 12}{10} \text{ inches} = \frac{96}{10} \text{ inches, or 9.6 inches,}$$

so that the speed is 8 feet 9.6 inches per second; but 8.8 feet is much preferable. Of course it is easy to select cases where this reduction is not so readily made. I think the chief objection to stating the velocity of wind in miles per hour, at any rate when the wind pressure is concerned, is that the latter being expressed in pounds per square foot, the same expression contains *two different* units of length, namely, the foot and the mile, being therefore irrational.

ADOPT THE KELVIN THERMOMETER SCALE AND THE METRIC SYSTEM.

By HENRY HELM CLAYTON. Dated Blue Hill, Mass., February 12, 1909.

I have read with interest the suggestions made by Prof. A. G. McAdie in the MONTHLY WEATHER REVIEW for November, 1908, p. 372. I wish very much that our Weather Bureau could see a way to adopt the metric system; but I believe it would be a misfortune if it should also adopt with it the centigrade thermometer scale. This scale is poorly adapted to meteorological work. In our climate [New England] nearly half the readings would be above and half below 0° C. This would be a constant source of confusion and mistakes. Each time the temperature fell below zero the observer would need to invert his method of reading. The normal method of estimating subdivisions in a vertical scale is to read the whole number on the scale and estimate the tenths upward. Thus if the thermometer reads 1.2° below zero the tendency is to read the 2° on the scale [next below the top of the mercury column] and estimate the tenths upward [to the top of the mercury column], thus making the reading −2.8° instead of −1.2° as it should be in reading downward. My experience convinces me that mistakes of this kind are not uncommon. Again it is confusing and a source of error to have two sets of values only distinguishable from each other by the presence or absence of a minus sign.

It is not uncommon to see in newspapers where matter must be printed hurriedly, and even sometimes in books, a temperature given without the minus sign. Thus a temperature of fifteen degrees below zero may be printed as 15° without the minus sign, hence, giving an entirely erroneous idea of its value. With the adoption of the centigrade scale the Bureau would need to be constantly on its guard against such errors. Again with half the values in a column of figures plus and half minus the addition for the purpose of obtaining means is very troublesome and would undoubtedly increase the time and cost of the work.

Hence I am led to renew a suggestion which I made ten years ago in Nature[1] namely that when the metric system comes into use by the English-speaking peoples, as it must in time, the Kelvin thermometer scale be adopted with it instead of the centigrade scale.

In the Kelvin scale the freezing point of water is 273° and the boiling point is 373°. It is a scale based on well-ascertained physical phenomena such as the rate of expansion of gases, the conductivity of metals, etc. It is a scale which enters into many of the mathematical formulas used in meteorology and it is a scale which is coming more and more into use for recording very low temperatures such as the freezing points of air and of hydrogen. So that if the centigrade scale were adopted there would still be two scales in use.

The only serious objection that I can see to the adoption of the Kelvin thermometric scale, is the increased number of figures required in recording and printing meteorological observations. But this is not so great as it appears. Printed columns of figures in degrees centigrade must, as a rule, reserve room for the printing of three figures to the left of the decimal point. It takes as much time and room to write −15° C. as it does to write the equivalent 258° K.

The adoption of the Kelvin scale with the metric system has already been recommended by a committee of the British Association (June, 1904) and if it should be adopted by the U. S. Weather Bureau either alone or in agreement with the English Meteorological Office, it would undoubtedly come into general use and become a universal scale, forever free from the troublesome below zero values.

[1] Nature, September 21, 1899, 60:491.

EXPRESS ALL BAROMETRIC MEASUREMENTS BY ORDINARY GENERAL UNITS OF FORCE.[1]

By Prof. Dr. W. KOEPPEN, Hamburg. Dated February 7, 1909.

[Translated by C. ABBE, jr., April, 1909.]

In the MONTHLY WEATHER REVIEW for November, 1908, Prof. A. G. McAdie, the well-known official in charge of the California Section of the U. S. Weather Service, makes a very noteworthy proposal. He recommends that the Weather Bureau should, as soon as possible, adopt the centigrade (not Celsius) scale and the metric system in measuring temperature, wind, rain, and snow; but he goes further and suggests that the Bureau should cut loose from the accident of the employment of mercury in the barometer and adopt as unity the mean standard pressure of 760 mm.=29.92 inches, calling it 1,000 for convenience sake.

The unification of the measures and scales of the meteorological world, through the adoption of the metric and centigrade systems by England and America, as suggested by Professor McAdie, is an advance most heartily to be desired. So extensive an observing system can not, however, be expected to change its present scales until persuaded of the perfect fitness and adaptation of that which is to be substituted. And it is not to be denied that our mode of expressing air pressure is still deficient in these lines.

Professor McAdie's proposal to adopt the pressure of 760 millimeters (which is already used in this sense as "one atmosphere") as the unit in all pressure measurements, would indeed bring about an undeniable advance were it not that this particular "normal pressure" or "Normaldruck" is a wholly conventional value. As is well known, the average barometric pressure even at sea level is very different for different places. Even this adopted value of 760 millimeters is only related to the metric system through a new quantity, the density of mercury. If this latter be eliminated, then the value 760 millimeters signifies a pressure of 1033.291 grams on 1 square centimeter if the gram is regarded as a unit of force. Physicists, however, recognize that it is more rational to conceive of the gram as a unit of mass, rather than a unit of force, and to take as unit of force the product gram × acceleration of gravity, i. e., value of 980.65 centimeters which is for latitude 45° at sea level. Thus a barometric reading of 760 millimeters, under normal gravity, corresponds in the C. G. S. system to 1,013,303 units. One

[1] Published simultaneously in Met. Zeitschr., May, 1909, 26:198–201.

million such units would correspond to a barometer at 750.1 millimeters. One may use this value as a unit calling it "one small atmosphere," or, with Bjerknes and Sandström,[2] 1 *Bar*. Then 1 *decibar* represents the pressure of a layer of distilled water at its maximum density and under standard gravity, 0.98 meter deep, or 1 megadyne per square centimeter.[3] A *millibar* is almost $\frac{3}{4}$, or more exactly 0.75006 millimeter mercury. The abreviations for these terms are naturally b., db., cb., mb.,[4] in agreement with the other abreviations of the metric system.

Starting with the customary assumption of 760 millimeters for the average pressure at sea level, we find the new pressure unit of 1,000 *mb* (or 750.1 millimeters) at an altitude of 106 meters above sea level.

The question as to whether or not the meteorologist should adopt this new higher level instead of sea level as a plane of reference to which to reduce the observations, is quite independent of the question as to the introduction of this new pressure scale. However, there are many considerations which are in favor of such a change, e. g., the average sea level altitude of the German stations in the Weather Report (Wetterberichte) of the Seewarte is exactly 107 meters (omitting the summit stations whose pressures are not reduced to sea level in these reports); 17 of these stations lie below 100 meters, Frankfurt a/M is 103 meters, and only 11 are above 106 meters. Similar conditions prevail, on the average, over the rest of Europe and in the eastern half of North America. Thus the new plane of reference would lie above the majority of stations, and the calculated, reduced pressure would have a real meaning, whereas at present the plane of reference lies in the earth below all the stations where "atmospheric pressure" means merely *a calculated value*, and the temperature used in making the reduction to sea level has no real existence. In the case of the remaining stations (those that still lie above the new reference plane) the distortions resulting from the reduction are at least lessened; indeed we may well regret that the level of the pressure unit did not happen to fall somewhat higher yet, for the pressure distribution at a level several hundred meters above the earth's surface is a much truer expression of atmospheric conditions than is the pressure at the surface itself. Indeed the lower air masses of the low-lying plains [of northern Germany] are in large part dragged along with the higher masses, i. e., they receive their impulses to motion chiefly from air masses descending from some height, since the friction and resistance at the surface is too great.

Already the desire has been frequently expressed that barometric readings should be reduced to a somewhat higher plane than that of sea level. It could not be realized because there has been small prospect of a general agreement upon some wholly arbitrary plane. The above proposed level is not altogether arbitrary, since it is as truly *the average plane of the unit of air pressure* as is 760 millimeters the mean pressure [measure] at sea level. Since the choice of this latter figure may vary within rather wide limits, one is also at liberty to choose, for the sake of convenience, an even hundred meters instead of 106 meters as the vertical interval up to this new plane of reference.

[2] Beiträge z. Phys. d. fr. Atmosph., Strassburg, 1906, **2**:1. Also Sandström and Helland-Hansen, Report on Norwegian Fish. and Marine Investig., 1902, **2**, No. 4, p. 15; and Knudsen in Bul. trimest. Internat. Comm. f. Meersf., 1906–7, No. 1, p. 41, No. 2, Pl. 14; and elsewhere.

[3] For the physical geographer it would be convenient to adopt as the unit pressure the pressure of a column of water 1 meter high, i. e., to call the acceleration of gravity at latitude 45°=1000 instead of 981; but one would then depart from the strict C. G. S. system. Therefore the Scandinavian scholars, in their oceanographic studies, use the "dynamic meter" of about 1.02 meters length; and thus they express pressure, friction, and the terrestrial deflecting force in terms of the same rational unit.

[4] In the article in the Beiträge, referred to above, *mmbar* is mistakenly used for *mbar* or *mb*.

One of the chief purposes of Professor McAdie's proposal has to do with the general public. He states that the public would then acquire more easily an idea as to the pressure conditions than now, when at present the figure "760" seems to be wholly arbitrary; we may well add that it must seem all the more arbitrary since most people know only the aneroid "barometer" and never associate mercury with the instrument. If, however, the business man reads, for example, 1009, he understands at once without calculating that the pressure is 0.009 above its normal value.

It must not be forgotten, however, that this is only true for barometer readings which are reduced to sea level. If the pressures of our weather reports were reduced to 106 meters or 100 meters above sea level the advantage claimed by McAdie would also pertain to them should my proposal be adopted; while for direct readings to which no corrections have been applied numerically or graphically either method is extremely inaccurate, McAdie's method being better for stations below 50 meters altitude, and mine better for places above 50 meters altitude. If, however, the readings are corrected then it makes but little difference whether the number 1000 or some larger one is used for comparison. In any case, it seems to me that this matter is of small significance in comparison with the advantages to be derived from a rational scale adapted to both scientific and technical purposes.

The following table gives the equivalents of the proposed units, in the units now in use. It is very seldom that the pressures at sea level fall outside the limits of the range of 100 *bar.*, from 950 *mb.* to 1,050 *mb.*

Inches.	Mm.	Mb.	Inches.	Mm.	Mb.
5.91	150.0	200.0	29.53	750 06	1000 0
11.81	300.0	400 0	29.92	760.00	1013.3
17.72	450.0	600 0	31.01	787.60	1050.0
23.62	600.0	800.0	31 89	810.10	1080.0
28.05	712.5	950.0			

It is not probable that those countries which already measure atmospheric pressure in millimeters will change their present system without a strong external stimulus. The advantages of the new system over the existing ones are not pronounced strongly enough for this, and there will be no inclination to lightly overturn the comprehensive unification [of methods] that has finally been accomplished [by international conventions], neither will the inconveniences of the transition period be incurred without some compelling reason. However, should the countries employing the English scales advance in this direction and should there be a well-founded prospect that by accepting this proposal a unification of the meteorological scales of the whole world might be accomplished, then the countries using the metric system would probably be glad to undergo the inconveniences of such a change, regarding them as the price paid for such a great advance. But such could only happen in case a really rational uniform system be offered, it would probably be impossible to secure general agreement to a purely empirical aid.

This reform need be carried out, at first only within meteorology itself. The technologist as well as the physicist and chemist would also probably soon use it because of the many advantages which the new system would offer him, but this can be left to time and meteorology does not need to delay adopting the change until a general agreement among all these branches of science has been secured.

METEOROLOGICAL REGISTRATIONS IN SAMOA, 1902-1906. I. WINDS.

By Dr. OTTO TETENS, Ph. D. Dated Berne, Switzerland, January 15, 1909.

In the September, 1908, number of the MONTHLY WEATHER REVIEW Mr. C. Fitzhugh Talman gives a short illustrated notice of the Samoa Observatory, which is under the auspices of the Royal Society of Sciences at Göttingen. The volume referred

to by him treats of the history of the geophysical observatory since its establishment in 1902. Volume 2, just published, contains the meteorological registrations for the years 1902–1906. Several figures, charts, and photographs accompany this volume.[1]

The observatory is situated about a mile northwest of Apia on the very extreme point of the Peninsula of Mulinuu. This spot was chosen as the basalt rocks of the interior of the island (Upolu) were here at the greatest distance and consequently their disturbing influence on the magnetic instruments was reduced to a minimum. The open and free location gave every possible advantage for the meteorological observations. The investigations are based on registrations of air pressure, temperature, humidity, and rainfall during a period of 50 months, of sunshine for 23 months, of wind for 12 months (November 1, 1902–December 31, 1906).

DIRECTION AND VELOCITY OF WIND.

In this part of the Pacific the trade winds generally blow from east-southeast to west-northwest, and thus their course is parallel to the direction of the Samoan group. Deviations of the trade winds from this direction are diminished on the northern and southern coasts of Upolu by the longitudinal range of mountains, which are 2,000 to 3,000 feet high.

Besides the air currents of the general circulation, the local land and sea breezes must also be considered. The land breeze at the observatory comes from the southern mountains and the sea breeze from a northerly direction. Owing to these local influences the trade winds are variable. At night and morning they are usually southeast, at noon and afternoon east-northeast.

The results of the wind registration are not conclusive, the collected data being for one year only. The apparatus used did not show wind velocities below 4 miles per hour, but lesser ones were recorded from the vibrations of the vane as shown on the direction apparatus. (The registration was affected by the influence of the tropical climate on the electric battery.) The anemometer was erected 50 feet above the ground, free from the surrounding cocoanut palms.

From the records obtained by this instrument hourly results have been derived. Table 1 shows the percentage of the different wind directions and calms and also the mean velocity in their annual variation.

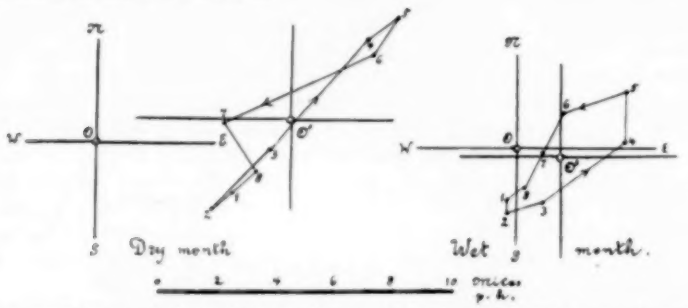

FIG. 1—Daily period of wind resultants, Apia, Samoa. The mean hourly wind resultants are represented by the points 1–8, as seen from the center O, each point showing the average for three hours. The intersection O′, represents the mean hourly resultant for the twenty-four hours. (See Table 4).

Table 1 shows that the trade wind blows 74 per cent of all hours. This average increases during the dry season (May to October) to 90 per cent and during the wet season still amounts to 59 per cent. Perfect calms seldom occur and then only during the night.

[1] Ergebnisse der Arbeiten des Samoa-Observatoriums der königlichen Gesellschaft der Wissenschaften zu Göttingen. II. Die meteorologischen Registrierungen der Jahre 1902–1906, von Otto Tetens und Franz Linke. Berlin, 1908. (Abhandlungen der königlichen Gesellschaft der Wissenschaften zu Göttingen, mathematisch-physikalische Klasse, Neue Folge, Band VII, No. 2.)

TABLE 1.—*Annual period of wind direction and velocity.*

1906.	Percentage of groups of winds.			Calms.	Mean velocity.
	Northerly. NW.–NE.	Easterly. ENE.–SSE.	Southerly and westerly. S.–WNW.		
Wet season:	%	%	%	%	*M. p. h.*
January	10.6	55.9	34.8	0.2	4.4
February	7.2	36.0	52.3	5.2	5.4
March	23.4	49.1	23.7	2.4	5.8
April	14.5	64.7	19.4	0.4	6.1
Dry season:					
May	8.8	83.3	4.8	1.9	6.9
June	3.7	91.7	0.7	3.5	7.5
July	10.0	83.5	1.8	2.4	6.4
August	3.3	95.7	1.0	0.6	10.6
September	2.5	96.8	0.7	0.0	8.0
October	9.0	86.5	4.0	0.0	7.4
Wet season:					
November	13.6	73.1	13.2	0.0	6.1
December	14.3	72.4	11.5	0.0	6.2
Year	10.2	74.0	13.8	1.4	6.7
Dry season	6.3	89.6	2.2	1.4	7.8
Wet season	14.0	58.6	25.6	1.4	5.7

Table 2 gives the percentage and the mean velocity for each of the sixteen directions during the year and its two seasons. These data are sufficient for computing the mean movement of each wind direction in miles per month, as shown by the last columns of the table.

Table 2 clearly demonstrates the overwhelming predominance of the east and east-northeast winds during the dry season and the relatively even distribution of the different winds during the wet season.

The mean monthly wind velocity varied, in 1906, from 4.4 miles per hour (January) to 10.6 (August). The average during the rainy season was 5.7 and during the dry season 7.8 miles per hour.

TABLE 2.—*Annual wind directions and movements.*

Wind direction. 1906.	Mean wind velocity.			Percentage from each direction.			Mean wind movement per month.		
	Year.	Season.		Year.	Season.		Year.	Season.	
		Dry.	Wet.		Dry.	Wet.		Dry.	Wet.
	M. p. h.	*M. p. h.*	*M. p. h.*	%	%	%	*Miles.*	*Miles.*	*Miles.*
N	5.4	4.9	5.9	0.5	0.4	0.6	20	14	26
NNE	5.7	4.9	6.4	1.8	1.3	2.3	88	51	124
NE	7.1	8.0	6.3	4.3	3.6	4.9	224	216	234
ENE	9.9	11.6	8.2	16.9	23.8	10.1	1,266	1,934	597
E	8.7	9.3	8.2	17.0	25.2	8.9	1,142	1,770	513
ESE	5.8	5.7	6.2	13.8	15.6	12.1	563	606	519
SE	4.6	4.4	4.8	13.1	13.8	12.4	452	480	423
SSE	4.3	4.2	4.3	13.2	11.2	15.1	409	344	475
S	4.5	4.4	4.7	1.9	0.4	3.4	79	45	113
SSW	4.5	4.4	4.5	4.4	0.7	8.2	148	34	262
SW	4.9	4.7	4.9	3.1	0.5	5.8	113	13	213
WSW	4.6	4.2	4.8	1.9	0.3	3.5	66	9	124
W	5.2	4.8	5.5	1.4	0.2	2.7	67	29	106
WNW	5.6	5.2	5.7	1.1	0.1	2.0	43	4	82
NW	5.3	5.1	6.4	1.9	0.5	3.3	96	28	163
NNW	6.3	5.4	7.2	1.7	0.5	2.9	89	21	157

The daily course of the wind velocity is parallel to that of the temperature; the maximum velocity occurs at 1 p. m., the minimum before sunrise. The following are the formulas obtained for the daily wind velocity in miles per hour:

Wet season.... $5.7 + 1.8 \sin (236° + h) + 0.5 \sin (65° + 2h)$.
Dry season.... $7.8 + 2.8 \sin (245° + h) + 1.1 \sin (71° + 2h)$.
Year.... $6.7 + 2.3 \sin (241° + h) + 0.8 \sin (70° + 2h)$.

Corresponding to the diurnal period of velocity there is also a diurnal variation in the direction. This is shown by Table 3.

From each of the two seasons a characteristic month has been taken as an example for computing the daily change of the mean resultant wind velocity and direction. Thus have

been derived the resultants given in Table 4, and shown graphically in fig. 1.

TABLE 3.—*Diurnal period of wind direction and velocity.*

1906.	Dry season.				Wet season.			
	Direction.			Departure from average velocity.	Direction.			Departure from average velocity.
	Highest.	Second.	Third.		Highest.	Second.	Third.	
	%	%	%	*M. p. h.*	%	%	%	*M. p. h.*
0-3 a. m.....	se. 26	sse. 22	ese. 19	−1.9	sse. 28	se. 16	ssw. 13	−1.4
3-6 a. m	se. 22	ese. 18	e. 16	−2.2	sse. 29	ssw. 17	se. 15	−1.6
6-9 a. m.....	e. 27	se. 18	sse. 18	−1.1	s-e. 18	se. 14	ssw. 12	−0.8
9-12 a. m.....	ene. 50	e. 27	ne. 15	+2.3	ene. 21	e. 18	ese. 15	+1.2
0-3 p. m.....	ene. 54	e. 23	ne. 12	+3.4	ene. 26	e. 15	ne. 13	+2.2
3-6 p. m.....	ene. 40	e. 33	ne. 5	+1.7	ene. 20	ese. 16	e. 12	+1.3
6-9 p. m.....	e. 37	ese. 22	{ene. 13 {se. 13	−0.9	se. 19	ese. 16	{e. 12 {sse. 12	0.0
9-12 p. m.....	se. 27	ese. 24	e. 24	−1.3	sse. 29	se. 16	ese. 15	−0.8

TABLE 4.—*Diurnal period of wind resultants.*

1906.	September. (Dry season.)		March. (Wet season.)	
	M. p. h.		*M. p. h.*	
(1) 0- 3 a. m.	4.9	n. 109° e.	1.7	n. 189° e.
(2) 3- 6 a. m.....	4.6	n. 120° e.	2.2	n. 187° e.
(3) 6- 9 a. m	6.0	n. 92° e.	1.9	n. 160- e.
(4) 9-12 a. m.....	9.9	n. 60° e.	3.7	n. 88° e.
(5) 0- 3 p. m.....	11.2	n. 68° e.	4.2	n. 62° e.
(6) 3- 6 p. m.....	9.9	n. 72° e.	2.0	n. 53° e.
(7) 6- 9 p. m.....	4.4	n. 81° e.	0.9	n. 97° e.
(8) 9-12 p. m	5.6	n. 100° e.	1.6	n. 166° e.

These figures clearly show the diurnal change, especially during the rainy season.

During the two seasons there seems to be a secondary daily wind maximum from 9 to 12 p. m.

The mean air movement and resultant direction are:

For the year..... 3,113 miles per month from N. 95° E.
For the dry season..... 4,675 miles per month from N. 90° E.
For the wet season..... 1,581 miles per month from N. 106° E.

The resultant mean winds, therefore, are due east during the dry season, and east-southeast during the wet season.

Effects of insolation on the diurnal wind period.

From seven bright and seven overcast days the results given in Table 5 have been derived. See also fig. 2.

TABLE 5.—*Effect of insolation.*

1906.	Departure from daily average.	
	7 bright days.	7 overcast days.
	M. p. h.	*M. p. h.*
0- 3 a. m.....	− 2.2	− 0.4
3- 6 a. m.....	− 2.3	− 1.3
6- 9 a. m.....	− 1.2	− 0.5
9-12 a. m.....	+ 3.3	+ 1.5
0- 3 p. m.....	+ 4.6	+ 1.6
3- 6 p. m.....	+ 1.6	− 0.3
6- 9 p. m.....	− 1.6	− 0.5
9-12 p. m.....	− 2.2	0.0

The difference between the highest and lowest mean hourly velocities is on the bright days, 7.5 miles, on the overcast ones only 4.1 miles. The daily average hourly velocity is 6.8 miles on the seven bright days, and 5.8 miles on the seven overcast days.

When the Besselian equations are formed, the following coefficients for the diurnal and semidiurnal terms of wind velocity result:

	Diurnal. *M. p. h.*	Semidiurnal. *M. p. h.*
Year.....	2.3	0.8
Seven bright days.....	3.5	1.5
Seven overcast days.....	1.0	1.1

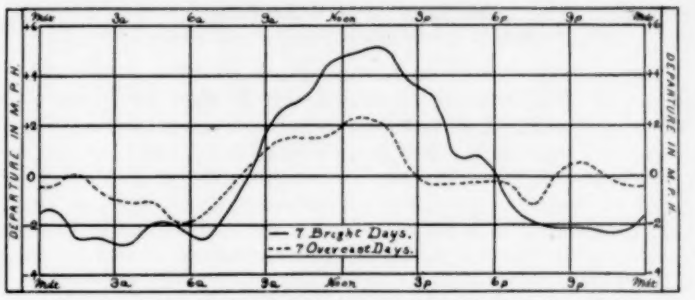

FIG. 2.—The effect of insolation on the daily wind period.

When referred to equal daily average velocity, the ratio of the daily terms is:

$$\frac{1.0}{3.5} \times \frac{6.8}{5.8} = 0.33.$$

The same seven bright and seven overcast days, when analyzed for temperature, give, for the corresponding ratio of the diurnal terms, the value 0.40. This close identity proves the diurnal variations of the velocity of the wind are mainly due to temperature.

The semidiurnal term, when examined in the same way, shows (contrary to the diurnal one) a remarkable independence of the thermal influence.

According to this result the secondary wind maximum mentioned before (9–12 p. m.), is to be expected, especially on overcast days, i. e., when the atmospheric equilibrium is more unstable than on bright days.

These conclusions may help to throw light upon the matter, but since they are based on fourteen days only, the results here derived will have to be confirmed by future observations in the Tropics.

METEOROLOGICAL OBSERVATORY AT TENERIFFE.

Solomon Berliner, American Consul at Teneriffe, reports under date of March 17, that a geophysical observatory[1] is being erected on the Cañadas, the plateau of the Peak of Teneriffe, at an altitude of about 8,000 feet (2,400 meters). This station will be known as the mountain or high-level station of Teneriffe (Höhenstation von Teneriffe).

The buildings, for which the foundations were already prepared at the time of the report, will be of asbestos and will accommodate both the instruments, apparatus, and members of the force employed at the observatory. The residence building is the gift of the Emperor of Germany, the money for the observatory building and the running expenses has been subscribed by the Prince of Monaco, by prominent citizens of the United States of America, and by German firms.

The high altitude of the station brings it above the level of the trade wind clouds so that the sky is almost perfectly clear throughout the year. This circumstance is particularly favorable to the principal object of the station, viz, continuous determinations of the intensity of the solar radiation. In addition to this and the very important studies of the trade wind by means of kites, magnetic and seismic records will be maintained and medico-biological studies will be instituted with a view to developing the hygienic value of the unusually sunny, dry climate and pure air of this peculiar plateau desert of the Canaries. The station will be under the general supervision of Professor Doctor Hergesell, of Strassburg, which is an assurance that its work and results will be of the highest order attainable.

Perhaps this station will furnish information about the northeast trade wind, as interesting as that about the southeast trade wind furnished by the anemometer on St. Helena.—*C. A., jr.*

[1] The corner stone of the observatory was laid by Professors Hergesell and Pannwitz, on March 21, 1909. See Zeitsch. Gesellsch. Erdkde., Berlin, 1909, p. 192.

ARGENTINE WEATHER.

By HERBERT L. SOLYOM. Dated Buenos Aires, January 9, 1909.

The scientific world in general hears so little of the meteorology of intertropical South America that every detail of articles concerning it deserves careful consideration. Hence it may not be out of place to call attention to one or two misapprehensions which might be originated by Prof. R. DeC. Ward's article on government meteorological work in Brazil, which appeared in a recent number of the MONTHLY WEATHER REVIEW,[1] even though these misapprehensions would be insignificant in connection with the meteorology of a better known region.

To one accustomed to study daily the Brazilian observations the implication that the weather changes in southern Brazil from Rio de Janeiro southward, are independent of the observed condition in the northern States of the Republic, and the statement that the rain of July 16–18, 1908, at Rio was associated with a weak cyclonic area whose influence did not extend much nearer the equator than Rio itself, are clearly in error though they would probably be accepted without question by most readers of the article.

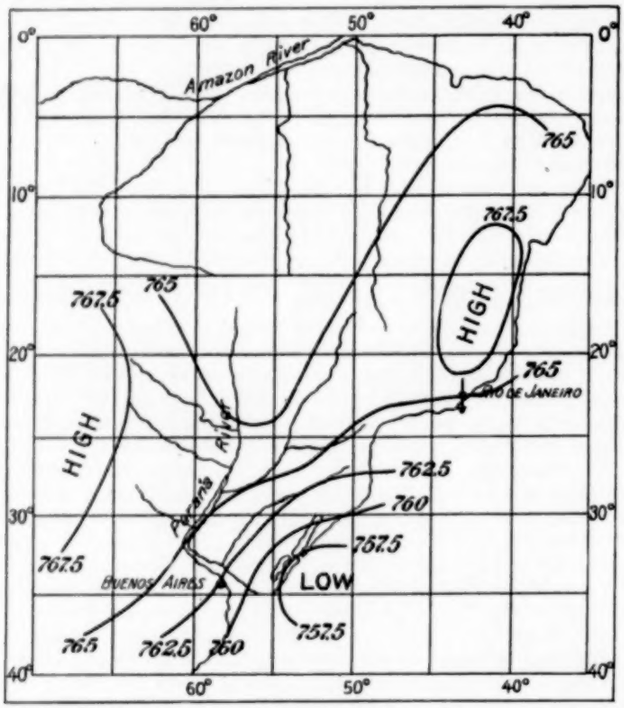

FIG. 1.—Weather Map of South America, July 13, 1908, 8 a. m. Cordoba time.

If one charts with the daily observations from the Brazilian stations, those from an equal or greater number of representative stations in the adjacent countries of Paraguay, Uruguay, and Argentina there results an intelligible weather map of this part of the continent, even though the great interior of Brazil is very inadequately represented and though there is a discrepancy of sixteen minutes between the observation hours of Brazil and Argentina.[2] The pressure distribution derived from a series of such maps extending over the period treated by Professor Ward, is presented on the outline maps forming figs. 1 to 8 of this paper. The isobars have been drawn for intervals of 2.5 millimeters, corresponding closely to the interval of the daily maps published by the U. S. Weather Bureau. In preparing these maps the barometric readings at Cuyabá, Jonzeiro, Victoria, and Bagé have been subjected to a nearly constant correction. The necessity for this becomes apparent after a study of a large number of maps and is thought to be due to either a large but unapplied instrumental error or more probably to the inaccurate determination of the sea-level altitudes of the stations. In the light of these additions and alternations the maps seem to show the following course of meteorological events during the middle of July, 1908.

On July 13, a well developed low pressure area, which had been causing moderate rains over a large area in eastern Argentina, is shown in fig. 1 to be moving out to sea across the coast of Uruguay. In spite of the near approach of this storm which was then causing rains at the southern Brazilian stations, the weather at Rio continued fair owing to the presence in northern Brazil of an irregular high pressure area with its center about latitude 16° S. and longitude 42° W. In the far western part of the map the anticyclone had just appeared which dominated the weather of the ensuing week.

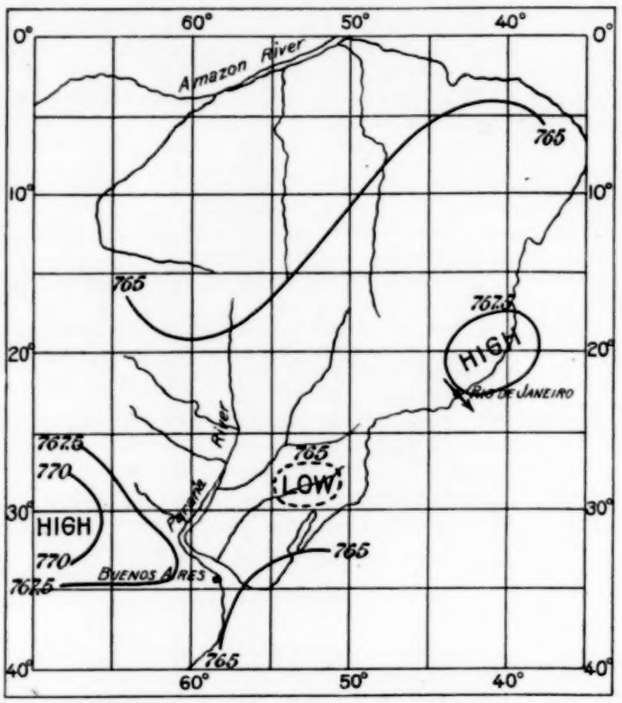

FIG. 2.—Weather Map of South America, July 14, 1908, 8 a. m. Cordoba time.

By the morning of the 14th the anticyclone of northern Brazil had contracted and moved slightly toward the south and east. At Rio the land wind continued and the vapor pressure was falling. The anticyclone of Argentina was increasing in intensity and spreading eastward while there is evidence that a shallow depression was developing in southern Brazil between two high pressure areas. On the morning of July 15 (see fig. 3) this depression appeared as a small, but well-defined cyclonic area and had begun to move eastward. The anticyclone in Brazil had disappeared leaving a region of uniform pressure in front of the new low-pressure area, while the high area over Argentina developed rapidly and drifted eastward. The definite pressure rise had begun at Rio, the wind had just shifted to the south and the vapor pressure was beginning to increase.

Between the 15th and the 16th the pressure rose steadily

[1] See Monthly Weather Review, August and September, 1908, 36:254–6, 290–2, Chart IX, (xxxvi–95).

[2] 8 a. m. Cordoba time is 12:16 p. m. Greenwich time.

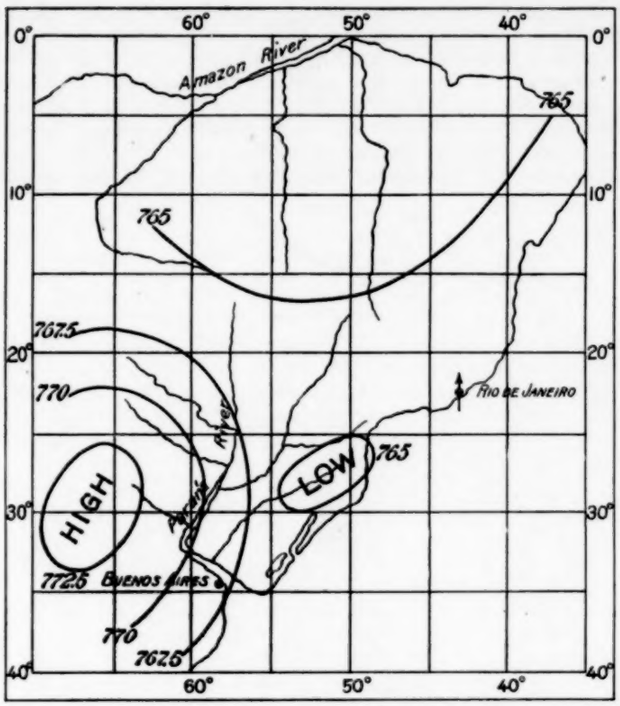

FIG. 3.—Weather Map of South America, July 15, 1908, 8 a. m. Cordoba time.

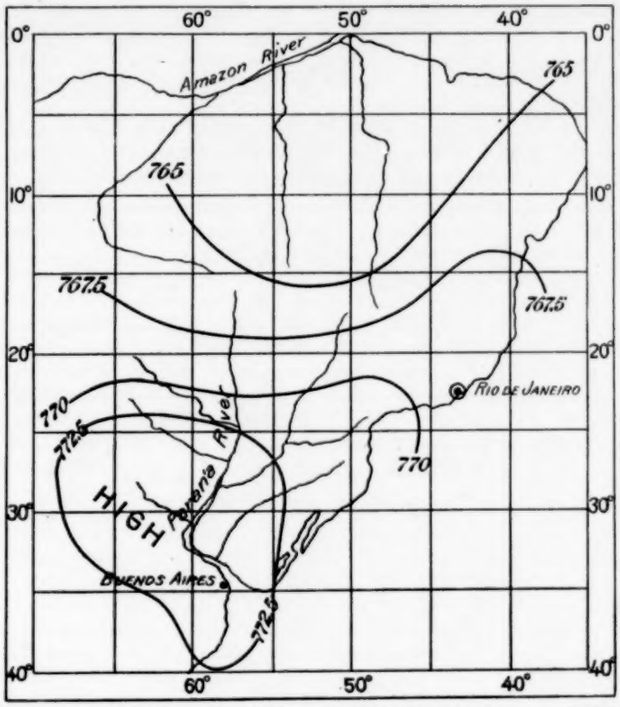

FIG. 5.—Weather Map of South America, July 17, 1908, 8 a. m. Cordoba time.

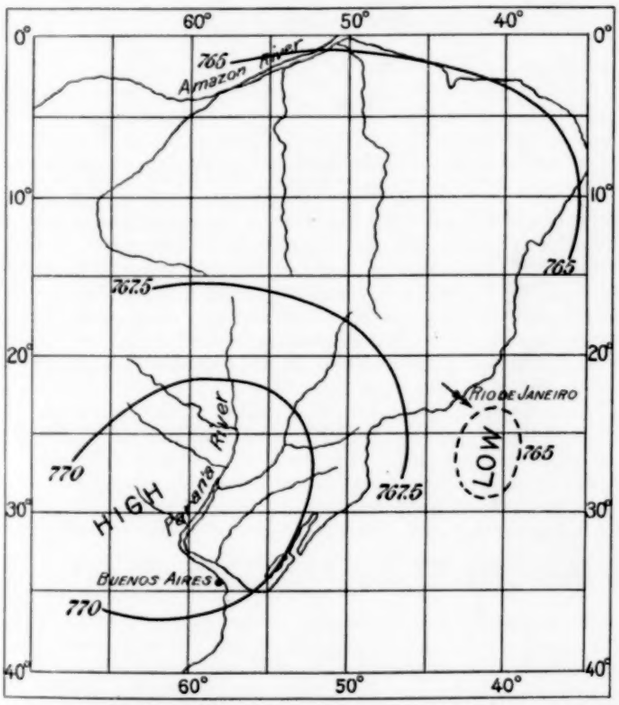

FIG. 4.—Weather Map of South America, July 16, 1908, 8 a. m, Cordoba time.

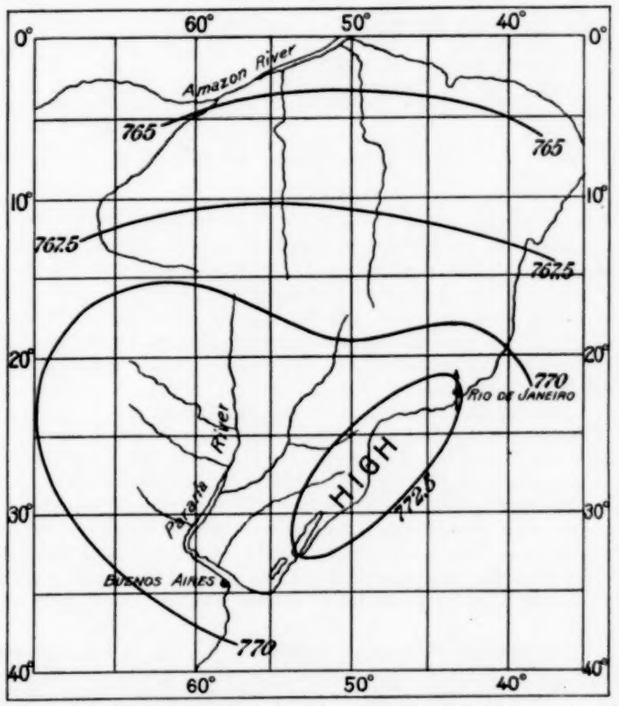

FIG. 6.—Weather Map of South America, July 18, 1908, 8 a. m. Cordoba time.

throughout Brazil, Paraguay, Uruguay, and eastern Argentina so that on the morning of the 16th (see fig. 4) the whole region embraced by the map was definitely within the area of the western anticyclone. The Brazilian low pressure of July 15th can not be placed on this chart "somewhere to the westward of Rio," as described by Ward. The only position that can be plausibly assigned to it, in order to account for the anomalous northwest wind at Rio de Janeiro, is that shown by the dotted closed isobar immediately south of that station; but this location is purely hypothetical while the fact that the vapor

pressure continued high and the cloudiness increased seems to indicate that this northwest wind was only local and temporary. In the latter case the low area must have filled in completely, or have moved rapidly to the east or southeast beyond the area of observations.

On the afternoon of July 16, rain began to fall at Rio, presumably with a return of the wind to the south and a continued rise in pressure as the auticyclone moved eastward.

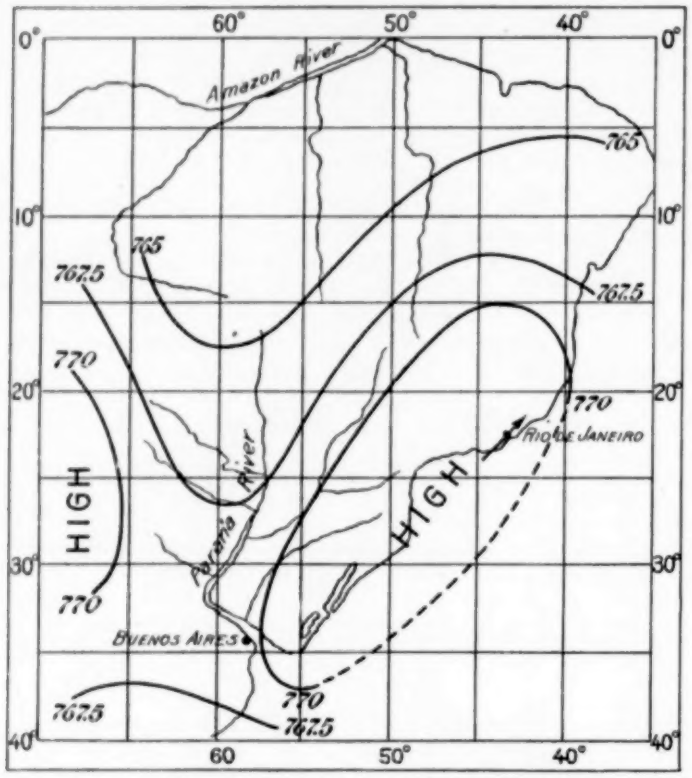

FIG. 7.—Weather Map of South America, July 19, 1908, 8 a. m., Cordoba time.

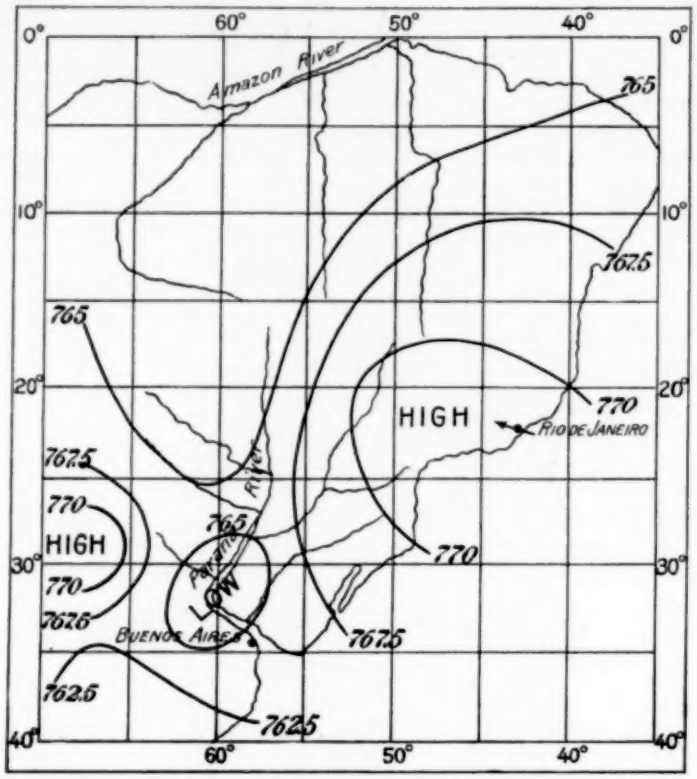

FIG. 8.—Weather map af South America, July 20, 1908, 8 a. m., Cordoba time.

The weather maps for July 17 and 18 (see figs. 5 and 6), show that the high-pressure area advanced steadily toward the coast, but that on the morning of the 18th it changed the direction of its advance to northeastward and followed along the coast until July 20. As the center of the high area approached the rain at Rio ceased and the sky began to clear. On the 20th the center of the anticyclone was located slightly to the south and west of Rio de Janeiro (see fig. 8), and a new low pressure had developed in central Argentina.

Thus the only influence that Professor Ward's "weak cyclonic area" had on the rain of July 16 to 18 at Rio de Janeiro seems to have been to delay its start by holding the winds in the northern quadrant for from twelve to twenty-four hours longer than they would otherwise have remained there. Furthermore, the rain which would naturally have resulted at Rio from the passage of a well-developed storm on July 13 was averted by the presence of a weak anticyclone in northern Brazil.

It is proper to here draw attention to the fact that a very large percentage of the rainfall in eastern South America occurs with a rising barometer and southerly winds whether this condition be produced by the recession of a low pressure or the advance of a high pressure. The rainfall is greatest when a low center is closely followed by a high.

It is true that the changes in pressure and temperature are but slight in northern Brazil, but they form a useful index to the probable course of atmospheric disturbances in higher latitudes and they should by no means be discarded. It should also be remarked that the criticisms directed against the Brazilian Meteorological Service, e. g., failure of telegraphic reports to arive on time, insufficient number of observing stations, the limited nature of the forecasts, etc., are simply those which would apply to any young service in a sparsely populated territory and will undoubtedly disappear in time. There are, however, one or two defects in the Brazilian system apparently not associated with the growth of the service. These are the partition of the work among different government departmeuts, the lack of effective cooperation between the national service and those of the individual States, and finally, the adherance to station pressures, instrumental constants and reduction tables which combine to give the isobars of the map weird contours dissimilar to anything observed in other countries, with barometric gradients out of all proportion to the observed wind velocities.

In conclusion, I would call attention to the fact that since the middle of November, 1908, the Brazilian Daily Bulletin has been substantially improved. It is now printed from type, includes the wind and cloud data and special comments opposite each station, and the map is reserved exclusively for the isobars which are drawn at 2- or 3-millimeter intervals.

THE SPECIFIC GRAVITY OF SNOW.

By M. E. J. GHEURY, F. R. A. S. Dated Eltham, England, March 4, 1909.

The following determinations of the specific gravity of snow were made at Eltham, England, during the winter of 1908–9. The samples for weighing were collected, usually in duplicate sometimes in larger numbers, from different parts of a flat roof by cutting out rectangular blocks of definite dimensions. These blocks were then weighed and the specific gravity computed. Some earlier determinations of the specific gravity of snow, will be found in the MONTHLY WEATHER REVIEW for December, 1907.[1]

[1] M. E. J. Gheury: The specific gravity of snow. Monthly Weather Review, 1907, 35:583.

December, 1908.

December 27. Minimum —0.1°C., maximum 0.6°C. It snowed all day until late at night.

December 28. Minimum —4.2°C., maximum —1.4°C.

The snow was lying on the ground, being formed of light feathery star crystals; it could be considerably reduced in volume by pressure and then adhered firmly together. Depth, about 2 inches.

Two pieces were cut from over a flat roof.

	1st Piece.	2d Piece.
Volume	4,570 cm³.	4,570 cm³.
Weight	196.5 gm.	211.4 gm.
Specific gravity	0.0430	0.0462

Specific gravity, average, 0.0446, say 0.045.

December 29. Minimum —4.7°C., maximum —3.9°C. It snowed all day until nightfall, with a strong driving wind. In the evening, two new pieces were cut from a part of the flat roof which had been cleared from the snow of the 27th. The snow was formed of very minute compact crystals, undergoing considerable reduction of volume under pressure and then adhering firmly together. Depth, about $3\frac{1}{8}$ inches.

	3d Piece.	4th Piece.
Volume	1,844 cm³.	1,844 cm³.
Weight	162.0 gm.	158.0 gm.
Specific gravity	0.0878	0.0856

Specific gravity, average, 0.0867, say 0.087.

This specific gravity is almost double that of the snow which fell in the 27th.

December 30. Minimum —8.3°C. The temperature remained below zero throughout the day, but rising gradually and passing by zero in the early morning of December 31. A little snow fell during the night, formed of small crystalline grains that could not be made to adhere together under pressure being very mobile upon one another somewhat like dry sand. Depth, about $\frac{1}{2}$ inch.

Two pieces of this fresh snow were cut from a part of the flat roof cleared from the snow of the 27th and 29th.

	5th Piece.	6th Piece.
Volume	1,303 cm³.	590 cm³
Weight	129.4 gm.	60.7 gm.
Specific gravity	0.0993	0.1029.

Specific gravity, average, 0.1011, say, 0.100.

It was then wished to investigate the effect of freezing on the fallen snow, and of the pressure of the fresh snow layers upon the old ones. For this purpose two pieces were cut from a part of the flat roof that had been left undisturbed, and the snow of which therefore consisted of three successive layers from the 27th, 29th, and night of 29th–30th. The total thickness was $3\frac{6}{8}$ inches as against $5\frac{5}{8}$ inches which was the sum of the individual falls.

	7th Piece.	8th Piece.
Volume	2,120 cm³.	2,120 cm³.
Weight	227.0 gm.	216.9 gm.
Specific gravity	0.1071	0.1023

Specific gravity, average, 0.1047, say, 0.105.

Two pieces were also cut from a part of the flat roof cleared on the 28th from all snow fallen on the 27th, the snow lying on that part thus consisting of the last two snowfalls only. Thickness, $3\frac{4}{8}$ inches (against $3\frac{5}{8}$ inches, the sum of the individual layers).

	9th Piece.	10th Piece.
Volume	2,143 cm³.	2,143 cm³.
Weight	211.7 gm.	208.6 gm.
Specific gravity	0.0988	0.0974

Specific gravity, average, 0.0981, say 0.098.

Reduction in thickness of second layer $= (3\frac{1}{8} + \frac{4}{8}) - 3\frac{4}{8} = \frac{1}{8}$ inch, that is $\frac{1}{8}$ out of $3\frac{1}{8}$ or $\frac{1}{25}$ of its former value. The volume being reduced to $\frac{24}{25}$ of its former value the specific gravity will have increased through this cause to $\frac{25}{24}$ of its former value and become $\frac{25}{24} \times 0.087 = 0.0906$. In the two layers, for a thickness of $3\frac{4}{8}$ inches, we have then 3 inches at 0.0906 and $\frac{4}{8}$ inch at 0.1011. The resulting specific gravity is 0.092 and it was found to be 0.098. Making allowance for the errors inherent to this kind of measurement, we can say that the whole of the increase in specific gravity seems due to compression caused by the weight of subsequent layers, the the action of the frost on the lying snow being very small unless, of course, it partially melts and recongeals.

Reduction of thickness of first layer $= (2 + 3\frac{4}{8}) - 3\frac{6}{8} = 1\frac{6}{8}$ inches. That is $1\frac{6}{8}$ out of 2 inches or $\frac{1}{8}$ of its former value. The volume being reduced to $\frac{1}{8}$ of its former value, the specific gravity will have increased through this cause to eight times its former value and becomes $8 \times 0.0446 = 0.3568$, say 0.357.

Two-eighths inch at 0.357 and $3\frac{4}{8}$ inches at 0.098 give a resultant specific gravity of 0.115. This agrees fairly well with 0.105, the value found for the three layers taken together, when we remember that 0.0446 is the mean of two determinations that were not in satisfactory agreement and that the error is being multiplied by 8, and the result found 0.357 may be affected by a serious error.

December 31. There was a gradual rise of temperature during the night. The thaw began. Maximum 6.8°C.

February, 1909.

February 26. Minimum —0.9°C., maximum 2.3°C. On this date and the 27th (minimum —1.7°C., maximum 1.7°C.), some powdery snow fell and lay on the ground. Early on February 27 very light thick flakes fell for sometime. After this the snow on the ground was found to consist of two layers of equal thickness, the lower one formed of round grains about 1 millimeter in diameter closely packed, the upper one of fine light fluffy spicules of ice. Blowing on the surface of the snow was sufficient to remove this upper layer, leaving the lower one undisturbed. Two pieces $\frac{7}{8}$ inch in thickness were cut on each side of a flat roof.

	1st Piece.	2d Piece.
Volume	2,066 cm³.	2,066 cm³.
Weight	186.2 gm.	190.6 gm.
Specific gravity	0.0901	0.0923

Specific gravity, average, 0.0912, say 0.091.

On the other side of the roof the snow was only $\frac{6}{8}$ inch deep.

	3d Piece.	4th Piece.
Volume	1,900 cm³.	1,771 cm³.
Weight	193.4 gm.	171.5 gm.
Specific gravity	0.0936	0.0968

Specific gravity, average, 0.0952, say 0.095.

The lower layer was found wet, as if it had begun to thaw slightly, this accounts for the increase in specific gravity.

The upper layer was then carefully blown away and snow belonging to the lower layer was collected. Its thickness was $\frac{7}{16}$ inch and it consisted of round grains, closely packed.

	5th Piece.	6th Piece.
Volume	951 cm³.	951 cm³.
Weight	163.8 gm.	157.9 gm.
Specific gravity	0.1660	0.1720

Specific gravity, average, 0.169, say 0.170.

On the other side, where the snow had slightly thawed it was $\frac{3}{8}$ inch in thickness.

	7th Piece.	8th Piece.
Volume	733 cm³.	799 cm³.
Weight	129.3 gm.	141.8 gm.
Specific gravity	0.176	0.178

Specific gravity, average, 0.177.

From these measures the specific gravity of the upper layer (removed by blowing) is easily obtained, the thickness of each layer being in both cases half the total thickness.

If x is the specific gravity of the upper layer; y the specific gravity of the lower layer; g the specific gravity of both layers together; $2v$ the total volume per unit area, then $vx+vy=2vg$, or $x+y=2g$ and $x=2g-y$. On one side of the roof $x=2\times 0.091-0.169=0.013$. On the other side of the roof $x=2\times 0.095-0.177=0.013$. The measures are thus in very good agreement throughout.

March, 1909.

March 1. Minimum —2.2°C., maximum 1.5°C. During the night snow fell abundantly, and this continued during part of the morning, when a layer of firm crackling snow covered the ground to a depth of about $2\frac{5}{8}$ inches. The snow was very compact and adherent undergoing little diminution of volume under pressure and reducing to a hard, solid mass. Special care was taken in cutting the pieces.

	1st Piece.	2d Piece.	3d Piece.
Volume	2,644.5 cm³.	2,809 cm³.	2,798 cm³.
Weight	168.8 gm.	172.8 gm.	164.4 gm.
Specific gravity	0.0638	0.0616	0.0587

Specific gravity, average, 0.0614, say 0.061, with a maximum error of $4\frac{1}{2}$ per cent.

March 2–3. After a very cold night (minimum —6.1°C.) it thawed slightly (maximum 2.8°C.) and the wind became southerly, but at night more snow fell, and on the morning of March 3 (minimum —1.3°C.) everything was again covered with a layer, $2\frac{5}{8}$ inches thick, of snow formed of small grains closely packed, adhering firmly together under pressure with a fair reduction in volume.

The ordinary method of securing a block of snow from the roof failed owing to the fact that the snow adhered to the tools so that small parts of the block always remained on the tools.

A tin box was therefore used, being laid squarely on the flat roof, bottom uppermost, the surrounding snow being then cleared and the imprisoned snow collected.

	Volume.	Weight.	Specific gravity.
1st Piece	1,618 cm³.	106.65 gm.	0.0659
2d Piece	1,618 cm³.	132.70 gm.	0.0819
3d Piece	1,618 cm³.	109.30 gm.	0.0675
4th Piece	1,618 cm³.	128.55 gm.	0.0795
Mean			0.0737

Specific gravity 0.074, with a maximum error of 11 per cent. This method does not seem as accurate as the method of cutting rectangular blocks.

Remark. The least specific gravity found was 0.013 for very light fluffy spicules of ice. The greatest specific gravity found (excluding the cases where the ice had begun melting) was 0.169, for closely packed round grains about 1 millimeter in diameter.

WEATHER BUREAU MEN AS EDUCATORS.

S. S. Bassler, Local Forecaster, Cincinnati, Ohio, read a paper on the Weather Bureau and its work, on March 16 before the Hyde Park Business Men's Club.

M. E. Blystone, Local Forecaster, Providence, R. I., lectured on the Weather Bureau and its work on March 9 and 30 before the Men's Club of two local churches.

George M. Chappel, Section Director, Des Moines, Iowa, reports that on March 25 he gave a lecture on the work and usefulness of the Weather Bureau, before students of the Iowa State College, Ames, Iowa; on March 24 students from the High School at Valley Junction, Iowa, visited the Local Office at Des Moines.

C. H. Eshleman, Observer, Grand Haven, Mich., reports that students from the Ottawa County Normal School visited the Grand Haven office on March 18 and 19, when he gave an hour's instruction on the development and movements of storms, and on the work of the Weather Bureau.

W. D. Fuller, Observer, Los Angeles, Cal., reports that the local office was visited on March 8 by a class from the State Normal School; and on the 10th by a class from the Yale School for boys.

R. T. Lindley, Observer, Asheville, N. C., reports an increasing interest, on the part of the local public, in the work of the Weather Bureau. He also reports that he has been asked to give daily instructions at the Biltmore Forestry School, Dr. C. A. Schenck, director. Recently the members of this school visited the Asheville office; as did also the class in physical geography from a local private school.

A. G. McAdie, Professor and District Forecaster, San Francisco, Cal., reports that on March 31 he delivered a lecture at Mount Tamalpais before 200 members of the Public School Teachers' Institute of Marin County.

Eric R. Miller, Local Forecaster, Madison, Wis., reports that on March 12 he addressed the Engineering Society and Club of the University of Wisconsin, on "The relation of the U. S. Weather Bureau to the engineer." On the 17th he addressed the class in hydrology, speaking on the scope of meteorology and climatology.

A. H. Thiessen, Section Director, Raleigh, N. C., reports that on March 8 his office was visited by a class in physics from the local Baptist University (for women). He also reports that the authorities of the State Agricultural and Mechanical College have granted him $25 for the purchase of lantern slides needed in his course to seniors in agriculture and others.

W. W. Thomas, Assistant Observer, Lewiston, Idaho, gave an informal talk on the work of the Weather Bureau, to students of the Lewiston State Normal School on March 24. After the talk his audience visited the local office where the workings of the service were explained and illustrated.—*C. A., jr.*

CHANGES IN THE MONTHLY WEATHER REVIEW.

The following are the latest orders concerning the changes in the MONTHLY WEATHER REVIEW.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
Washington, D. C., April 12, 1909.

1. With the view to better meeting the requirements of the public services under control of the United States Weather Bureau and the associated bureaus named in Instructions No. 76, 1908, the system of compiling and publishing meteorological data by the Weather Bureau is hereby modified so that, beginning with July 1, 1909, such data will be grouped according to natural topographic districts and published in a consolidated and unified form.

2. For this purpose the United States has been divided into twelve climatological districts conforming to its twelve principal drainage areas, outlined on the accompanying map (Chart IX). This scheme of division has been adopted as affording the best system of territorial units for the compilation and discussion of climatological data and has been agreed to by the associated bureaus. For these reasons the districts adopted will be adhered to as far as practicable in matters of administration, in the publication of correlated observations, and in the distribution of meteorological data, especially as affecting agriculture, transportation, irrigation, forestry, and engineering. In these lines of work each large district will be under the supervision of a selected division director, but in the supervision of substations and in the collection of observations section directors will continue their present duties within their respective States.

3. The publication of the monthly section reports of the climatological service, except those for Iowa, Porto Rico, and Hawaii, will be discontinued with the issue for June, 1909.

4. Beginning with the issue for July, 1909, the Monthly Weather Review will be devoted exclusively to the publication and discussion of climatological, river, and forecast data. Special articles of a scientific nature, but not strictly climatological, will be published in the Bulletin of the Mount Weather Observatory or in separate form. The editing of the Review will be under the general supervision of the Chief of the Climatological Division, in collaboration with the twelve directors in charge of the climatological districts, who will be designated division editors. The Review will contain twelve sections de-

voted to the climatology of the United States for the month, and in addition thereto such other matter from the Forecast Division, the River and Flood Service, and the associated bureaus as the Chief of Bureau may direct. Division editors and section directors will be expected to incorporate in their monthly reports notes regarding matters of importance pertaining to irrigation, forestry, engineering, agriculture, transportation, and related subjects. A plan of cooperation between officials of the associated bureaus and the Weather Bureau is contemplated whereby such information will be collected for the Review.

5. Each section director will prepare monthly the following data:

(*a*) The matter appearing on the page of the monthly section reports as now published headed,
Climatological data for.....

(*b*) That appearing on the page headed,
Daily precipitation for.....

(*c*) The daily maximum and minimum temperatures for not more than ten selected stations in his State, the number depending upon the relation the State bears to the climatological district, or districts, to which it belongs.

(*d*) A brief general summary giving the most important facts concerning the weather for the month in the State.

6. The data for that portion of a State lying within any one of the twelve climatological districts will be forwarded to the division editor for that district, together with a copy of the State summary for the use of the editor in preparing a general summary for the district. It will be the duty of the division editors to prepare the data for their districts in form for publication and transmit them to the Climatological Division of the Central Office to be finally revised and printed. From the summaries and notes sent to them by the various section directors the division editors will be expected to prepare papers of scientific value and of practical interest to the public.

7. The correspondence necessary in the carrying out of the foregoing instructions is hereby authorized.

8. Hereafter the National Weather Bulletin will be issued monthly instead of weekly. The publication of the bulletins heretofore issued weekly at the section centers during the crop growing seasons, except for Iowa, Hawaii, and Porto Rico, will not be resumed.

Existing instructions that conflict with the foregoing are hereby revoked.

(Signed) WILLIS L. MOORE,
Chief U. S. Weather Bureau.

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——

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Poppe, T. W. Storm and lightning protection to line wires. p. 797–798. (Apr. 1.)

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Bowman, Isaiah. Man and climatic change in South America. p. 267–278.

Oldham, R. D. Recent earthquakes. p. 294–297.

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Omori, F. Note on the long-period variations of the atmospheric pressure. p. 215–222.

Omori, F. Experiments on the vibration of brick columns. p. 223–228.

Nature. London. v. 80. 1909.

Eve, A. S. Ionisation in the atmosphere. p. 36–37. (Mar. 11.) [Experiments showing that the "Ebert" apparatus and others of like type are misleading in indicating a large excess of positive over negative electricity in the atmosphere.]

Ashworth, J. R. Is there a vertical magnetic force in a cyclone? p. 40. (Mar. 11.)

Gold, E. The isothermal layer of the atmosphere. p. 68. (Mar. 18.)

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Harvey, Frederic A. Atmospheric radioactivity in California and Colorado and the range of the *a*-particles from radium *B*. p. 188–216.

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Ley, C. H. Balloon observations at Birdhill, Co. Limerick, during July and August, 1908. p. 15–29.

Oldham, R. D. Earthquake weather. p. 30. [Extract from Nature.]

Bruce, Eric Stuart. Some forms of scientific kites. p. 31–35.

Cave, C. J. P. The registering balloon ascents in the British Isles, July 27–August 1, 1908. p. 37–42.

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Assmann, Richard. The German aerological expedition for the exploration of the upper air in tropical East Africa, July to December, 1908. p. 51–54.

—— The snowfall of December 29, 1908. p. 54.

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Geikie, James. Calabrian earthquakes. p. 113–126.

—— The Argentine's Antarctic meteorological station. p. 151.

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Devereux, H. B. The cyclone and floods of January, 1907, in New Zealand. p. 36–37.

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France. Académie des sciences. Comptes rendus. Paris. Tome 148. 1 mars, 1909.

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Grossmann, —. Dr. Ernest Kohlschütter: Höhenmessungen in Deutsch-Ostafrika. p. 67–74.

Everdingen, E. van. Ueber die Ermittelung des Winkels zwischen Gradient und Windrichtung. p. 75.

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Hann, J[ulius]. Zum Klima von Palästina. Meteorologische Beobachtungen zu Athroun (Latrun) 1901 bis 1906. p. 82–83.

Knoche, W. Eine Beobachtungen des Leuchtens über den Anden zu Valparaiso. p. 83–84.

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Wulf, Th. Ueber die in der Atmosphäre vorhandene Strahlung von hoher Durchdringungsfähigkeit. p. 152–156. (1. März.)

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Exner, Felix M. Grundzüge einer Theorie der synoptischen Luftdruckveränderungen. II. Mitteilung. p. 819–854. (April.)

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Schmid, —. Ueber Böen. p. 44–45.

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RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Librarian.

The following have been selected from among the titles of books recently received, as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies. Most of them can be lent for a limited time to officials and employees who make application for them. Anonymous publications are indicated by a ——.

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Annual report ... 1908. Madras. 1909. 26 p. f°.

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AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

By MRS. GRACE J. LIVINGSTON. Dated Washington, D. C., January 8, 1908.

[*Continued from the Monthly Weather Review, February, 1909.*]

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Alexandre, F.
Note relative à la mesure de l'évaporation de l'eau. Congrès de mét., Expos. univ. int. de Paris, 1878, Compt. rend. sténog., no. 20: 207–16. 1879. Also Paris. 1881. 12 p. 8vo.

Describes experiments carried on at Angoulême with a rectangular sheet iron evaporator 1.5 meters by 1 meter by 40 centimeters, with cement bottom and an outlet. The difficulty of reading, owing to small oscillations of the water surface, was obviated by floating in the large tank a smaller basin, 225 millimeters in diameter, the level of the water in which was observed to tenths of a milimeter by means of a sheet iron float which actuated a pointer. Corrections were made for the influence of heat on the walls of the apparatus and on the water. Tables of other meteorological observations accompany those of evaporation. The maximum daily evaporation for the summer, 9 millimeters, occurred on August 1 with the maximum temperature of the air, 34° C., and of the water, 31° C.

Beaudrimont, A.
Evaporation de l'eau sous l'influence de la radiation solaire ayant traversé des verres colorés. Compt. rend., 1879, **89**: 41–3; and Monit. sci., 1879, **21**: 1076–80. Abstract in Ciel et Terre, 1881, **1**: 404–5.

Observations of the variation in rate of evaporation of water under the influence of solar radiation through different colored glass. Yellow and colorless glass produced the most evaporation, red the least. (See Marié-Davy, 1873, 2d title.)

Borius.
De l'identité des résultats fournis au Sénégal par l'observation de l'évaporomètre de Piche et du papier ozonométrique de Jame (de Sedan). Congrès de mét., Expos. univ. int. de Paris, 1878, Comp. rend. sténog., no. 20: 187–8. 1879.

Curves of the evaporation as measured by the Piche evaporometer, and of the ozone of the atmosphere as indicated by ozone-paper, when drawn with zero points in opposition continued almost exactly identical for thirty months. In spite of detected uncertainties in the ozonometric method the author considers it very interesting to ascertain that both physical and chemical methods furnish identical results. He considers that the value of the Piche instrument as a means of research remains to be determined, and that it does not lie in its use as an evaporometer.

Cantoni, Giovanni.
Sulle condizioni di forma e di esposizione pui opportune per gli evaporimetri. Rend. r. ist. Lomb., 1879, **12** (ser. 2): 941–6. Reviewed in Riv. sci. ind., 1880, **12**: 49. Abstract in Zeits. Oest. Ges. Met., 1881, **16**: 39–40.

Describes a modification of the Piche evaporometer, designed to remove difficulties arising from hydrostatic pressure. It is pointed out that evaporation depends not only on temperature, humidity, and area of the evaporating surface, but also on the amount of water in the dish, on the mass and thermal conductivity of the material of the dish, on the ratio between the mass of water and the surface of the dish, on the ratio between the diameter and the depth of the liquid, and on the movement of air about the dish.

Cantoni, G.
Sugli evaporometri e sulla temperatura dell'aria. Ann. uffic. cent. met. Ital., 1879, **1** (ser. 2): 47–59.

Emphasizes the importance of exposure of the evaporometer.

Cantoni, G.
Quels progrès ont fait les méthodes pour la détermination de l'évaporation? Rap. deux. congrès mét. int. de Rome, 1879: 123–4.

Distinguishes between observations of evaporation for meteorological and for agricultural purposes; and, in the former case, advises the dimensions of the atmometer be reduced to the utmost, since the difference between the temperature of the air and that of the water increases as the mass of the water in the basin and in the whole apparatus increases.

Ebermayer, E.
Bericht über die Fragen 18 (Bestimmung der Bodentemperatur), und 21 (Verdunstungsbeobachtungen), des Programme für den Meteorologen Congress in Rom. Leipsic. 1879. 8vo. Also Rap. deux. congrès mét. int. de Rome, 1879: 87–9, 91–5.

Groups instruments for measuring the evaporation of water into two classes: (1) those for scientific researches, e. g., Osnaghi's (1874), Morgenstern's, and Hough's (1874) recording; and (2) those for practical studies. The latter class should be exposed to a variety of climates.
Describes Morgenstern's instrument as consisting of a moist paper 10 centimeters by 10 centimeters, stretched on a frame and absorbing water by capillarity from a burette placed below it. This is apparently not the same form described by Symons, 1876.
Recommends form, construction, and manipulation of instruments.

Höhnel, Franz.
Ueber die Transpirationsgrössen der forstlichen Holzgewächse mit Beziehung auf die forstlich-meteorologischen Verhältnisse. Zeits. Oest. Ges. Met., 1879, **14**: 286–91.

An experiment conducted from June to November compared water loss from fifteen different kinds of young trees replanted in air-tight pots, and it was found that birch lost most and black fir least. The amount of water loss was compared with the rainfall for the period.

Modena, Reale Osservatorio.
Osservazioni sulla evaporazione. Ann. soc. met. ital., 1879, **2**.

Mohn, H.
Grundzüge der Meteorologie. Berlin. 1875. 2d ed.

See Mohn, 1875.

Sun spots and the Nile. Nature, 1879, **19**: 299.

Points out a coincidence between frequency of sun spots, increased rainfall, and increased evaporation.

Ragona, D.
Esperienze sulla evaporazione. Ann. soc. met. ital., 1879, **2**.

Ragona, D.
Évaporomètre enregistreur. Congrès de mét., Expos. univ. int. de Paris, 1878, Compt. rend. sténog., no. 20: 25. 1879.

A balanced evaporating dish rises as its weight diminishes by evaporation, drawing with it a marking pointer which moves in front of but without touching a revolving cylinder. Every quarter of an hour a hammer, actuated by a clock movement, presses the pointer against the cylinder and registers the distortion of the balance, and hence the amount of evaporation.

Riegler, Wahrmund.
Das evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1879, **14**: 368–74. Abstract in Forsch. Geb. Agr. Phys., 1880, **3**: 111–2.

The evaporation from a free water surface is to that from a Piche evaporometer as 1:2.03. Discusses the defects and advantages of the Piche instrument.

Russell, H. C.
Meteorology of New South Wales. Results of rain and river observations made in New South Wales. Sydney. 1879.

The series appeared under various titles, as follows: 1878, Results of rain observations made in New South Wales; 1879–88, Results of rain and river observations... (1886 included observations in Queensland); 1889–94, Results of rain, river, and evaporation observations... All these reports contain results of observations of evaporation. See Symons, 1890, for amount of evaporation which Russell has found possible at Sydney and other stations in New South Wales.

Skinner, J. D.
Table of daily evaporation at the sources of the Mississippi River, autumn 1878. Rpt. Chf. Eng., 1879, pt. 2:1226–7.

The rate of evaporation from a freely exposed pan of water was shown to be nearly twice as great as that from a pan in the shade or from one set in a marsh.

Symons, G. J.
[Address by, before the Sanitary Institute at Croyden.] Symons's met. mag., 1879, **14**:164.

"Hygrometry is almost identical with the measurement of evaporation, but not quite, because hygrometry considers the amount of moisture in the air at rest, and evaporation is the resultant of the average of a variable number of miles of air of a variable hygrometric condition over a water surface."

Todd, Charles.
Meteorological observations made at the Adelaide Observatory during the year 1878. Adelaide. 1879. Review in Symons's met. mag., 1880, **15**:72–4.

The reviewer believes there is no European observatory where such judicious arrangements for measuring evaporation are in operation as these at Adelaide. One evaporator consists of a zinc-lined wooden tank 4 by 4 by 3.5 feet, sunk 3 feet in the ground. It is filled with water nearly to the top, and the level of the water is observed by means of a vertical rod moved by rack and pinion and reading by vernier to 0.01 inch. A second instrument consists of a cubical slate tank, 3 feet on a side, placed in a larger cement-lined brick tank 4.5 by 4.5 by 3.25 feet. Both are filled with water to the same level. The evaporation from the inner tank is measured on a graduated vertical rod carried by a float. A table comparing the two instruments shows less evaporation from the slate tank than from the wooden one. In 1878 the total from the latter was 58.8 inches, from the former, 69.19 inches.

Volland.
Ueber Verdunstung und Insolation, ein Beitrag zur besseren Kenntniss des Hochgebirgsklimas. Basel. Switzerland. 1879. 34 p. 8 vo. Abstract in Fortsch. f. Met., 1879, **15**:102–2.

Observations made simultaneously at Davos, Switzerland, and Strassburg, Germany, of the evaporation of water from small vessels protected from sun and rain, but freely accessible to the air, show by weekly weighings that: (1) loss by evaporation is less on high mountains than on lowlands; (2) the rarer air and decreased atmospheric pressure of high altitudes has a lower capacity for water vapor, and thus retards evaporation; (3) insolation on mountain tops is lower in summer and higher in winter than on the lowlands, and for the same reason as in (2); (4) on mountain tops the air is driest in winter.

1880.

Croll, James.
Aqueous vapor in relation to perpetual snow. Amer. jour. sci., 1880, **20** (3d ser.): 103–5. Extract in Mo. weather rev., October, 1880, [**8**]:16.

Points out that snow evaporates even when the temperature is below the freezing point.

Ebermayer, E.
Beschreibung einer Methode zur Bestimmung der Durchlässigkeit und Verdunstungsgrösse der verschiedenen Bodenarten. Protokol der Int. Konf. für Agrarmet. Vienna. 1880.

Forster, A.
Ueber das Verhältniss der Angaben des Evaporimeter Piche zu denen des Wild'schen Waagevaporimeter. Jahrb. tellur. Obs. Bern. 1880. Also Forsch. Geb. Agr. Phys., 1881, **4**:466–8.

The rates of evaporation from the Piche and from the Wild evaporometers were compared from May, 1879, to October, 1880. The Piche instrument gave a rate per square centimeter of exposed surface, 1.99 to 2.22 times greater than that of the Wild instrument. (See Shaw, 1882.)

Haughton, Samuel.
Six lectures on Physical Geography. Dublin and London. 1880. p. 123.

Gives general estimates of evaporation.

Houzeau, J. C. and A. Lancaster.
Traité élementaire de météorologie. Paris. 1880. Review in Symons's met. mag., 1881, **16**:73–6.

Draws attention to the rôle played by evaporation as affecting sensible temperatures in polar regions or elsewhere under very low temperatures.

Kunze, M. F.
Das Evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1880, **15**:21–2. Review in Forsch. Geb. Agr. Phys., 1881, **4**:468; Ciel et Terre, 1881, **1**:44–5.

Experiments similar to Riegler's, 1879, compare the rate of evaporation from a Piche evaporometer and from a free water surface, from October 20 to November 14, 1879. The ratios found, 1.05, 1.12, or 1.09, are much smaller than those found by Riegler. The two instruments agreed almost exactly during the night, but during the day the Piche instrument showed a higher rate, due probably to the heating of the high thin walls of the tube.

Lancaster, A.
See Houzeau, J. C., and A. Lancaster, 1880.

Lavel.
Recherches sur l'évaporation et sur les causes qui la modifient. Mém. soc. sci. phys. et nat. Bordeaux, 1880, **3**.

Lommel, E.
Wind und Wetter. Leipsic. 1880.

Describes Prestel's (1864) atmometer on p. 49.

Masure, Félix.
Recherches sur l'évaporation de l'eau libre, de l'eau contenue dans les terres arables, et sur la transpiration des plantes. Ann. agron., 1880, **6**:441–500. Abstracts in Forsch. Geb. Agr. Phys., 1880, **4**:135–8; Symons's met. mag., 1881, **16**:67–8.

Describes measurements at Orléans, of the rate of evaporation from water, soil, and vegetation, from August 6, to November 15, accompanied by observations of the temperatures of the air and water, the relative humidity, etc. Derives the following expression for evaporation:

$$h = K\frac{F_{t'}}{H}(F_{t'} - UF_t).$$

where h = millimeters of water evaporated in six hours, t = mean temperature of the air for the six hours, t' = mean temperature of the water, F_t = maximum vapor pressure at the temperature of the air, $F_{t'}$ = maximum vapor pressure at the temperature of the water, U = mean relative humidity, H = barometric pressure, K = constant depending on such secondary factors as solar radiation, the weather, the wind, the electrical and chemical state of the air, etc. A table compares the rates of evaporation from soil under different conditions of moisture, and from free water surfaces, shows that wet soil evaporates more and a dry soil *less* than a free water surface. The transpiration of plants is regarded as a complex phenomenon. The average daily evaporation from a water surface at Orléans, during the period studied, was 163.8 millimeters, 48.02 millimeters in the forenoon, 101.32 millimeters in the afternoon, and 14.46 millimeters during the night.

Stelling, Ed.
Ueber den jährlichen Gang der Verdunstung in Russland. Repert. f. Met., 1880, **7**, No. 6: 1–75. Also (with a plate of curves) St. Petersburg. 1880. 4to. Abstracts in Zeits. Oest. Ges. Met., 1881, **16**:117–9; Forsch. Geb. Agr. Phys., 1881, **4**: 132–5; Fortsch. f. Met., 1881, **7**: 75–80.

A study of evaporation at 23 stations in Russia, with Wild's evaporometer, from 1872, shows the minimum to occur generally in January and the maximum in July. The form of the curve is determined by relative humidity and temperature. Weilenmann's formula is quoted as showing a methematical relation between these elements and evaporation. The expression $V = a(G - g)$, in which a = a constant, G = the weight of the water vapor per unit volume of saturated air at the given temperature, and g = the actual weight of the water vapor per unit volume, may also be written $V = aG\left(1 - \frac{g}{G}\right)$. It is shown that $\frac{g}{G}$ = the relative humidity, r, therefore if r is expressed in per cent, the equation becomes $V = a'G(100 - r)$. G, a function of the temperature, increases in geometrical progression as the temperature increases in arithmetical progression. This equation suggests: (1) At constant temperature the evaporation is inversely proportional to the relative humidity; (2) the influence of the relative humidity on the absolute amount of increase or decrease of evaporation is greater at high temperatures than at lower. Observations of rainfall and other meteorological elements are given, and curves present evaporation rates for eleven stations.

Wollny, E.
Untersuchungen über den Einfluss der oberflächlichen Abtrocknung des Bodens auf dessen Temperatur- und Feuchtigkeitsverhältnisse. Forsch. Geb. Agr. Phys., 1880, **3**: 325-48.

Shows that a dry surface layer to a great degree retards evaporation from the soil.

1881.

Blanford, H. F.
Description of a rain gauge with evaporometer, for remote and secluded stations. Jour. Asiat. soc. Bengal, 1881, **50** (pt. 2): 83-5. Also Proc. Asiat. soc. Bengal, 1881,(–):76-7.

Fornioni, G.
Di un evaporimetro a livello costante. Rend. r. ist. Lomb., 1881, **14**: 356-9.

The instrument consists of an evaporating dish connected with a supply reservoir by a glass tube. A spring raises the reservoir as the water is consumed, thus keeping the water in the evaporating dish at a constant level. The movement of the reservoir is transmitted by means of a thread and pulley to the pointer of a dial which indicates the amount evaporated.

Forster, A.
Ueber den täglichen und jährlichen Gang der Verdunstung in Bern. Jahrb. tellur. Obs. Bern, 1881, (—):5–7. Abstract in Forsch. Geb. Agr. Phys., 1881, **4**:465–6.

Observations were made twice daily of the rate of evaporation from a Wild evaporometer exposed in a thermometer shelter, from March, 1878, to December, 1880. The maximum daily amount for this period, 49 millimeters, occurred in July, 1880, and the minimum, 2.5 millimeters, in December, 1879.

Garban.
On the rate of evaporation. Paper read at the Réunion annuelle des sociétés savantes in Paris in 1881. Abstract in Symons's met. mag., 1881, **16**: 66.

According to Ramsay (1884), Garban's experiments on the rate of evaporation from various soils showed a lower rate from chalk than from sand, the latter appearing to collect most dew and vapor and to yield its vapor more readily than any other variety of soil.

Gilbert, J. H.
See Lawes, J. B.

Gugliemo, G.
Sulla evaporazione dell' acqua e sull' assorbimento del vapore acqueo per effetto delle soluzioni saline. Turin. 1881. 8vo. 21 p.

Kunze, M. F.
Das Evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1881, **16**:30–1.

The experiments described in Kunze's paper of 1880 were continued from April to October, 1880. They give 0.670 as the ratio of evaporation from a free water surface to that from the Piche instrument for April, and 0.732 for July.

Lawes, J. B., J. H. Gilbert, and R. Warington.
On the amount and composition of the rain and drainage waters collected at Rothamsted. Parts I and II. Jour. roy. agr. soc., 1881, 17 (ser. 2): 241–79, 311–50.

Description of the elaborate means employed at Rothamsted to isolate in its natural condition a plot of soil. A table of rainfall, drainage, and evaporation for the period 1870–80 shows the annual evaporation ranging from 14.279 to 19.686 inches. Finds that the average evaporation from soil bare of vegetation, in a climate having a mean temperature of 48° F., will be nearly 12 inches during the six summer months, about 5.5 inches during the six winter months, and 17 to 18 inches for the whole year. Discusses the results obtained by others along this line, describes the form of Dalton's percolation gage, as used by Maurice, Gasparin, Dickinson and Evans, Greaves, Ebermayer, Sturtevant, etc. In all these cases the soil was too loose to approximate the natural conditions and grass was allowed to grow, thus increasing the evaporation. Gives Graves's [Greaves'?] results from a similar experiment with a mass of pure sand, showing the average drainage and evaporation for the fourteen years, 1860–73.

Ragona, D.
Andamento diurno e annuale della evaporazione. Mem. reg. accad. sci. Modena, 1881, 1, (ser. 2). Also Modena. 1881. 28 p. 4to. Reviewed in Zeits. Oest. Ges. Met., 1882, 17:242–3; Ann. soc. mét., 1882, 30: 35–7.

The reviewer doubts Ragona's statement that there is no daily periodicity in the rate of evaporation as shown by his self-recording evaporometer (see Ragona, 1879); also that the winter months show a negative evaporation. These apparently incorrect observations are attributed to the method used.

Russell, Henry Chamberlain.
Evaporation. Min. proc. intercol. met. conf. at Melbourne, April, 1881. Melbourne. 1881. 4to. p. 12–13.

Results of observations with three forms of evaporators, 1871–1880.

Shaw, W. N.
Report on hygrometers and evaporimeters, presented to the Meteorological Council May 10, 1881. Metl. council rpt., 1881, (—): 28–30.

Instruments of the same pattern as described in Shaw, 1877, are used in these experiments. The different forms gave the following widely divergent results:

Instruments.	Evaporation.
	Mm.
Lamont	3.88
de la Rue (1)	3.61
de la Rue (2)	3.16
Wild	2.85
Piche	97.3

Estimates that 20 millimeters of the Piche scale are equivalent to 1 millimeter of evaporation from a free water surface.

Stefan, J.
Ueber die Verdampfung aus einem kreisförmig oder elliptisch begrenzten Becken. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1881, 83 (pt. 2): 943. Abstract in Zeits. Oest. Ges. Met., 1882, 17: 63–8.

A study of the laws of evaporation from circular and elliptical vessels brings out the facts that, whereas one would expect a much higher rate of evaporation from an elliptical surface than from a circular one of equal area, this is only the case for those ellipses whose major axis is many times greater than the minor one. Otherwise the evaporation from an elliptical surface is but little greater than from a circular one. The evaporation from a large water surface is relatively less than that from a small one, because the amount of vaporization is not proportional to the area but to the square root of the area.

Stefan, J. and Maxwell, [J. C.]
Theorie des Psychrometers. Zeits. Oest. Ges. Met., 1881, 16:177–82.

Mathematical discussion of the laws of psychrometry. German translation of J. C. Maxwell's article, "Theory of the wet-bulb thermometer," Encyc. Brit., 9th ed., vol. 7, p. 218–19, article "Diffusion." Edinburgh. 1877.

Stelling, Ed.
Ueber die Bestimmung der absoluten Grösse der Verdunstung von einer freien Wasserfläche nach den Beobachtungen im Observatorium in Pawlowsk. Repert. f. Met., 1881, 8, (Kl. Mitt. No. 2):10–9. Review in Zeits. Oest. Ges. Met., 1882, 17:373. Ciel et Terre, 1883, 3: 214.

Wild, at Pavlovsk in the summer of 1878, found that the temperature in his floating evaporometer was sometimes as much as 10° C. higher than that of the water in the pond. In 1880 the apparatus was altered so that the two temperatures agreed very closely. Calculations by the Dalton-Wellenmann formula (Wellenmann, 1877) showed that the indications of the evaporometer could then, with hardly any correction, be taken as the evaporation from the free surface of the pond. The formula is $v = A\Sigma(S-s) + B\Sigma(S-s)w$. A and B are constants under general conditions, v = the rate of evaporation, S = the vapor pressure of saturation at the temperature of the water, s = the vapor pressure at the dew-point, and w = wind velocity in meters per second. Describes his floating instrument.

Symons, G. J.
A contribution to the history of hygrometers, (read March 16, 1881). Quart. jour. roy. met. soc., 1881, 7(n. s.):161–185.

Gives a chronological list from 1644 to 1879 of the inventors of hygrometers, with a brief description of each instrument. Also an alphabetical list of the same with bibliographic references.

Symons, G. J.
Evaporation. Brit. rainf., 1881, (—): 46.

A general discussion of the influence of the size of the evaporator on the rate of evaporation, and of the necessity of using large evaporating surfaces to secure results comparable with the actual evaporation from large natural bodies of water. Gives the recommendations of the Agricultural Congress at Vienna in 1880 regarding study of evaporation.

Violi, A.
Sull' evaporazione dell' acqua. Rend. r. ist. Lomb., 1881, 14:576–80.

The influence of the area of the evaporating surface upon the rate of evaporation is considered subordinate to that of the temperature and relative humidity.

Warington, R.
See Lawes, J. B., etc.

Wollny, E.
Bericht über die Verhandlungen und Ergebnisse der internationalen Conferenz für land- und forstwirthschaftliche Meteorologie, abgehalten in Wien in den Tagen vom 6–9, September, 1880. (Aus den Sitzungsprotokollen zusammengestellt und mit Bemerkungen versehen.) Forsch. Geb. Agr. Phys., 1881, 4: 276–305. Translated in Quart. jour. roy. met. soc., 1881, 7:117–20.

[Wollny, E.]
Resolutions adopted by the Conference for the development of Agriculture and Forest Meteorology, held at Vienna in September, 1880. Quart. jour. roy. met. soc., 1881, 7: 117–20.

"The Conference is of the opinion that observations of evaporation are important, but that no existing instrument can be proposed for general and exclusive use. In fact it is recognized as an immediate requirement to devise satisfactory instruments and especially such as would admit of the accurate measurement not only from free water surfaces but also from different soils in the fallow and cropped states. Meanwhile, observations on evaporation should not be neglected, but they should be conducted with simple forms of apparatus, especially those depending on weight, as well as with the Piche atmometer modified according to the suggestions of Professor Cantoni." (See Cantoni, 1879.)

1882.

Carl, Philipp.
Ein einfacher Verdunstungsmesser. Repert. der Phys., 1882, 18: 630–1.

An evaporating vessel is laterally connected by a rubber tube with a graduated glass cylinder, which can be raised and lowered. The zero point of the scale is brought to the same level as the opening from the evaporating dish into the connecting tube. Water is poured into the apparatus until it stands at this level. The graduated cylinder is then raised so that water rises and fills the evaporating dish. At the end of a definite period the fall of the water level in the graduated vessel can be directly observed.

L' évaporation. Ciel et Terre, 1882, 3:91–2.

Discusses the questions raised by Tacchini, de Lesseps, and Symons, regarding the necessity of large evaporating vessels for approximating natural conditions. Concludes that the rate of evaporation increases in proportion as the size of the evaporometer employed diminishes.

Cunningham, Allan.
Recent hydraulic experiments. Proc. inst. civ. engin., 1882, 7:1–36.

Measurements of evaporation were made on the Ganges canal near Roorkee in northern India for 25 months, during 1876–9. The evaporator was a zinc pan, 12 by 12 by 9 inches, resting in a wooden frame and buoyed by air chambers so as to float on the surface of the canal. The observed rate of evaporation was remarkably low, the average being only 0.10 inch per day; whereas 0.50 inch per day is said to be a common rate for Indian land exposures. The cause of the low rate appears to be the extreme coldness of the canal water which is from the snow-fed Ganges. On May 22, 1877, at 2:30 p. m., the air temperature was 165° F. in the sun, and 105° in the shade, while the water was only 66° inside the pan and 65° in the canal. The highest recorded temperature of the canal water was only 75.5° F. The total evaporation from the whole surface of the canal and its branches was estimated at about 47 cubic feet per second, about 1/150 of the full supply of the canal or the entire supply for ten minutes daily.

Decaudin-Labesse.
Marche diurne et annuelle de l'évaporation, par le Prof. D. Ragona, directeur de l'Observatoire de Modène. Ann. soc. mét., 1882, 30:35–7.

Many variations but no certain periodicity, are shown in Ragona's curve of daily evaporation (see Ragona, 1881.) The influence of wind on evaporation is shown to be such that "if all other instruments were lacking, the self-recording evaporometer would suffice to indicate strong gusts of wind, even when the evaporometer is sheltered." Ragona's formula is $E = 0.18259\,T - 0.01823\,U + 0.15145\,F$, where T=temperature, U=relative humidity, F=the velocity of wind in kilometers per hour. The reviewer expresses surprise at evidences of "negative evaporation." The differences between the temperatures of the air and dew-point are tabulated, showing that this difference is very small in winter when "negative evaporation" often occurs. The rate in a closed sunless place seems to be governed by the same laws as those for an open sunny place. The maxima and minima for the year follow those of the temperature. The total annual evaporation at Modena is determined as 2223.10 millimeters.

Dewar, D.
A new theory of Nature; containing observations on weather, tides, capillary attraction, evaporation, and sun-spots. London. 1882.

In experiments with evaporation from water in capillary tubes, it was shown that in vessels having surfaces and bases of equal areas, the smaller the free surface and the less the height of the liquid the greater is the evaporation.

Freeman, S. H.
On the question of electrification by evaporation. Phil. mag., 1882, 13 (5):398–406. Notice in Ciel et Terre, 1883, 4:287–8.

The theory that evaporation is the source of atmospheric electricity, first proposed by Volta and upheld more or less by Pouillet, Tait, and Wanklyn, is here controverted. "If the charges of electricity produced in experiments with evaporation are really due to evaporation (and not to friction and leakage, as is more probable), and if evaporation is the principal source of atmospheric electricity, the calculations of the amount of evaporation necessary to produce one flash of lightning show that a much greater quantity of water would be required than is ever found in a thunder-cloud." Further the total annual evaporation from the earth will not account for the annual number of lightning flashes usually observable from any one place.

Langer, Th.
Vergleichende Beobachtungen mit dem Evaporimeter Piche unter vielerlei Exposition. Forsch. Geb. Agr. Phys., 1882, 5:105. Abstract in Zeits. Oest. Ges. Met., 1882, 17:375.

Experiments comparing the rate of evaporation from four Piche atmometers in different exposures, were conducted during the summer months of 1880, accompanied by observations on the temperature of each, the cloudiness, relative humidity, pressure, and wind velocity. The rate increased with the degree of exposure. The Piche, and particularly the form as modified by Cantoni (1879), is recommended for the purposes of agricultural meteorology.

Latham, B.
Experiments with Greaves's floating evaporator. Proc. inst. civ. engin., 1882, 71:47. (In the discussion following the paper by Cunningham, 1882.)

For a general description of this apparatus see Symons, 1869. In these experiments the author brings out the fact that too high evaporation rate may be produced by the capillary action of the water on the sides of the vessel. From a number of evaporators painted different colors the rate was always higher, even from the black, than from the plain copper, because the painted surfaces induced greater capillary action than metal. Further experiments show the influence of the size of the vessel, the larger the vessel in proportion to the surface exposed to evaporation, the smaller is the marginal ring up which the water passes by capillarity and the less is the evaporation rate.

Robie, David.
Rain and Dalton gages. A letter to the Editor. Symons's met. mag., 1882, 17:184–6.

Experiments with the Dalton gage at Bedford, England, showed that in 1882 almost half the 28.42 inches of rainfall was evaporated. The monthly percentages of this amount that percolated into the soil were as follows: January, 83; February, 50; March, 68; April, 43; May, 54; June, 20; July, 51; August, 8; September, 40; October, 46; November, 67; December, 94. Dalton gages of various depths in operation at Rothamsted show that the moisture in the soil may be drawn up from considerable depths by evaporation, one gage being 5 feet deep.

Sresnevski, Boris.
Ueber die Verdampfung von Flüssigkeiten. Jour. Russ. phys. chem. soc., 1882, 14:420–69, 487–98. Abstract in Beibl. Ann. Phys. und Chem., 1883, 7:888–90.

In the investigation of an atmometer constructed by Petrushevski, which allows evaporation not from a flat surface but from the curved surface of a drop segment (Tropfensegmente), it developed that the amount of evaporation is proportional to the circumference of the segment and not to the surface. This confirms the conclusion reached theoretically by Stefan in 1881, that the amount of liquid evaporation from a circular hole in a flat surface should be proportional to the circumference of the hole.

Stelling, Ed.
Ueber die Abhängigkeit der Verdunstung des Wassers von seiner Temperatur und von der Feuchtigkeit und Bewegung der Luft. St. Petersburg. 1882. 42 p. 4to. Also Repert. f. Met., 1882, 8: No. 3. Abstract in Zeits. Oest. Ges. Met., 1882, 17:372–3.

Observations of the evaporation (by a Wild evaporometer) and other meteorological elements were made every two hours at Nukuss from May to September, 1875. He uses the Dalton-Weilenmann formula [see Stelling, 1881], $dw = A(S-s)dz + B(S-s)wdz$, in which dw = the evaporation in millimeters for the time dz, S = the vapor pressure of saturated air at the temperature of the evaporating water, s = the actual vapor pressure of the air in millimeters of mercury, w = the wind velocity in kilometers per hour, and A and B are constants evaluated from the observed evaporation depth. Concludes that the Dalton-Weilenmann formula is reliable to within ± 10 per cent of the actual depth of evaporation in the open and to within ± 15 per cent of that depth under a shelter.

van Tricht, P. Victor.
Évaporomètre à plongeur. Ciel et Terre, 1882, 3:430–2.

Describes in detail the design of an evaporometer of the Lamont (1868) type.

Verdunstungsmesser in Pawlowsk. Zeits. Oest. Ges. Met., 1882, 17: 367–8.

Describes and illustrates the floating evaporometer devised by Wild and described by Stelling, 1881.

Wiedemann, Gustav.
Die Lehre von der Electricität. Braunschweig. 1882. 5 vol.

In 1: 240–1 and 4: 628–9, there is a general discussion of the generation of electricity by evaporation, and of the influence of electrification on evaporation.

1883.

Blake, Lucien.
On the production of electricity by evaporation, and on the electrical neutrality of vapor arising from electrified still surfaces of liquids. Phil. mag., 1883, 16(5): 211–24. Reviewed in Ann. Phys. und Chem., 1883, No. 7; Zeits. Oest. Ges. Met., 1882, 17:482; Ciel et Terre, 1883, 4: 311–12.

Two different methods of experimentation lead to the conclusion that "the charge [produced by evaporation from sea-water] is too small in proportion to the sea-water evaporated, to be used as a basis for mathematical calculations concerning the electricity resident in the clouds [see Freeman, 1882]. Nor is it a sufficient ground for the assertion that the simple change of a liquid into a vapor produces electricity." Other experiments seem to show that "the vapor arising from electrified still surfaces of liquids is electrically neutral."

L'eau tombée et l'évaporation à la surface de la terre. Ciel et Terre, 1883, 4: 18–20.

Abstract of John Murray's estimates of evaporation from rainfall and run-off.

Dieulafait.
Évaporation de l'eau de mer dans le sud de France et en particulier dans la delta du Rhône. Compt. rend., 1883, 96: 1787–90.

From experiments on the French Mediterranean coast in the region of the delta of the Rhone, it is concluded that the average daily evaporation from sea-water, even at some distance out from land, is at least 6 millimeters.

Dieulafait.
Évaporation des eaux marines et des eaux douces, dans la delta du Rhône et à Constantine. Compt. rend., 1883, 97: 500–2.

The ratio between the evaporation of salt water and fresh, stated by Roudaire as 62:100 is believed to be inexact. The ratio found by the weighing method was not lower than 96.5:100, and it is shown that theoretically this ratio is not less than 98:100 for normal sea water. Observations conducted by Pelletreau at Constantine show an average daily evaporation of 8 millimeters from May 1 to December 1, 1881. The daily average for the year is calculated as 6.6 millimeters or 6.3 millimeters from sea water.

Lalanne.
[Note on a paper by Salles.] Compt. rend., 1883, 97:349–50.

In connection with Roudaire's plan of an inland sea, the experiments of Salles, 1883, are mentioned as showing that evaporation is not so great from large bodies of water as observations of evaporation from small instruments seem to indicate.

Latham, B.
Evaporation from irrigated rye grass at Croydon. Proc. inst. civ. engin., 1883, 73:238.

In discussing O'Meara, 1883, the author cites experiments on the rate of evaporation from an artificially isolated plot of irrigated rye grass, showing a loss by evaporation of 183.3 inches from June 18, 1870, to June 12, 1871, while the rainfall for that period was 20.03 inches.

O'Meara, Patrick.
The introduction of irrigation into new countries, as illustrated in northeast Colorado. Proc. inst. civ. engin., 1883, 73:178–212.

Discussion of problems arising in an investigation of irrigation possibilities, such as evaporation from soil, evaporation of snow, and evaporation from reservoirs.

Ragona, D.
Andamento diurno e annuale della evaporazione. Mem. reg. accad. sci. Modena, 1883, 1 (ser. 2):145–70.

This article is mainly occupied with errors and corrections of the formula developed in Ragona, 1881 (see Decaudin-Labesse, 1882). The effect of wind on evaporation is illustrated by a typical daily curve.

Salles, A.
Expériences sur l'évaporation faites à Arles pendant l'années 1876 à 1882. Comp. rend., 1883, 97:347–9.

Observations of the evaporation from water in three masonry tanks 3 meters square, with the surface of the water at various levels. Special instruments were designed for accurate measurements. The average annual evaporation was 1.050 meters. A Piche atmometer gave 2.200 meters. Previous observations by Gasparin at Orange (sixteen years) gave 1.876 meters; by Cotte at Cavaillon (two years), 2.192 meters; by Cotte at Arles (five years), 2.563 meters, and by Valles at Marseilles, 2.350 meters. The Ingénieurs de ponts et chaussées at Dijon found 0.594 meter from large basins of masonry.

Sresnevski, Boris.
Ueber die Verdampfung von Flüssigkeiten. Jour. Russ. phys. chem. soc., 1883, 15:1–9.

Concludes his paper of 1882.

Tromelin, G. le Goarant de.
La grêle, les trombes, l'électricité atmosphèrique. Rev. sci., 1883, pt. 1 (—):779–85. Translated in Phil. mag., 1884, 17 (5):245–7.

Believes that atmospheric electricity results from the friction present in wind-caused evaporation; but does not believe quiet evaporation can produce electricity in unchanged air.

1884.

Abbe, Cleveland.
Progress in meteorology in the year 1883. Ann. rept. Smithsn. inst. for 1883. Washington. 1884. p. 27, 43, 65.

Summarizes Stefan's (1881) investigations, discusses the relation of evaporation to electricity according to Blake (1883), describes the Stelling and Wild evaporometer, (see Stelling 1881), and reviews Langer's (1882) results with a Piche instrument.

Acireale, Osservatorio Meteorologico Pennisi.
Riassunto delle osservazioni meteorologische 1882–3. Acireale. 1884.

A table of humidity, evaporation, and rainfall for 1882–3 gives totals by decades and months. The total observed annual evaporation was 1694.2 millimeters and the rainfall 967.5 millimeters.

Decaudin-Labesse.
See H. Mohn, 1884.

Descroix, Léon.
Sur l'exagération du pouvoir évaporant de l'air à l'équinoxe du printemps. Compt. rend., 1884, 98:1352–5. Abstract in Ann. soc. mét., 1884, 32:209.

From observations with a Piche evaporometer it is concluded that "general vaporization of pure water at the surface of the paper varies as the ratio between the square of the number which measures the lowering of the dew-point on one side and the atmospheric temperature on the other." The author notes an increase in the evaporating power of the air in the spring, also the fact that evaporation under widely different temperatures, (11° C., afternoon in spring, 22° C. in midsummer), may be absolutely the same, although the relative humidity is not lower in April than in July. A table gives the comparative range of evaporation and related meteorological phenomena from 1873–84.

Eser, Carl.
Untersuchungen über den Einfluss der physikalischen und chemischen Eigenschaften des Bodens auf dessen Verdunstungsvermögen. Forsch. Geb. Agr. Phys., 1884, 7:1–124. Review in Met. Zeits., 1885, 2:430–2. Abstract in Fortsch. f. Met., 1885, 11:37–41.

Includes critical reviews of the work of Schübler, Meister, Wolff, Nessler, Heilriegel, Haberlandt, Johnson, etc., on transpiration and evaporation from soil. From the author's own experiments it is concluded: (1) Evaporation depends mainly on the amount of water in the soil; all soils evaporate equally when saturated. (2) The evaporating surface is at the surface until the saturation of the soil is less than 50 per cent when the evaporating surface sinks. (3) Evaporation depends on the porosity of the upper layers and is decreased by the drying of the surface. (4) Soils of a high rate of evaporation lose less water as they dry out than those having a lower rate. (5) Evaporation from a rough surface is greater than that from a smooth surface. (6) The physical structure and organic content of the soil are of primary importance because of the water capacity and capillarity; humus evaporates most, sand least, and clay is intermediate. (7) Evaporation is greater from the darker colored soil. (8) The soil covering is more important than the soil itself; plant-covered soil evaporates most, bare soil next, straw-covered land least. (9) Capillarity may cause salts to accumulate at the top. (10) Manures containing salts retard evaporation by increasing the salt content of the surface layer. (11) Inclined surfaces evaporate moisture at rates in the following order, south, east, west, and north. (12) Evaporation varies with the seasons. (13) Evaporation is in proportion to insolation.

Mohn, H.
Les phénomènes de l'atmosphère. Traduit par Decaudin-Labesse. Paris. 1884. p. 25, 105–12, 114, 129.

Discusses the rôle of water vapor in the movements of the atmosphere. Defines and states laws of evaporation and heat of vaporization. Describes and figures the Delahaye evaporometer. General discussion of the causes which determine the amount of evaporation. Figures for total annual evaporation given for different localities.

Ragona, D.
Andamente annuale della evaporazione. Ann. met. ital., Ser. II, 1884, **6** (pt. 1): 57–67. Also Rome. 1886. 16 p. 4to.

Devises a mathematical expression, employing the meteorological elements, by which the calculated evaporation agrees closely with the observed evaporation at Modena for five-day periods from 1879–1885. The instrument used was a simple cylindrical glass dish with a device for obtaining accurate readings of the level of the water.

Ramsay, Alexander.
A bibliography, guide, and index to climate. In the Scientific Roll and Magazine of Systematized Notes. London. 1884.

For evaporation see under Aqueous Vapor: Bibliography, 1682–1883 (incl.) and Notes, p. 177–449.

Symons, G. J.
Evaporation. Brit. Rainf., 1884, (—): 9.

Notice of the removal to Camden Square, early in 1883, of the large tank (Symons, 1870) which had been used for observing evaporation at Strathfield Turgiss.

Viñes, Benito.
Observaciones magneticas y meteorologicas del Real Colegio de Belen de la Compañia de Jesus de Habana, Ano de 1875. Habana. 1884. 4to.

Evaporation records for Habana, Cuba.

Wollny, E.
Untersuchungen über die Wassercapacität und das Verdunstungsvermögen verschiedener Streumaterialien. Forsch. Geb. Agr. Phys., 1884, **7**:309–321.

Soil mulches, peat, loam, and sand, allow greater evaporation than mulches of dead plant parts. Among the last the moss mulch allows greater evaporation than one of needle leaves or of broad leaves, the latter being the most effective in retaining soil moisture.

1885.

Acireale, Osservatorio Meteorologico Pennisi.
Riassunto delle osservazioni meteorologiche, 1883–4. Acireale. 1885.

Table of evaporation, rainfall, and humidity for 1883–4. Total evaporation, 1686.1 millimeters, and rainfall, 942.3 millimeters.

Chabaneix, J.-B.
Évaporomètre du sol. Bul. mét. Hérault, 1885, (—): 79–86.

Describes a complicated arrangement for isolating soil in order to determine the rate of evaporation of its moisture. A zinc evaporating vessel, 30 by 30 by 30 centimeters, is filled with soil and buried in the ground. A spout from a gutter around the upper edge leads the excess of rainfall to a bottle. An underground reservoir supplies water by capillarity to the soil experimented with. Water is introduced into the reservoir, and thence to the whole apparatus, by a tube leading from the surface of the soil.

Guillemin, Amédée.
Le Monde Physique. Paris. 1885. 5 vol.

Descriptions are given of the Piche and the Delahay evaporometers, and a self-recording weighing apparatus, for determining evaporation from soils and plants. Tables of observations with the Piche instrument compare the rates of evaporation for day and night, also for summer and winter. Another table gives the annual evaporation in different parts of the world and the total annual evaporation from the earth's entire surface. (Volume 5, p. 223–8.)

Haslam, E.
Measurement of evaporation. Nature, 1885, **32**:357.

Describes a differential evaporometer in which water flows from a reservoir through an evaporating tank into an overflow receiver. The loss from the reservoir minus the gain in the receiver equals the evaporation from the exposed surface.

Houdailles F.
Études des pluies de 1885. Bul. mét. Hérault, 1885, (—):41–60.

A comparison of monthly rainfall with the simultaneous evaporation furnishes a factor expressing the relative humidity of each month.

Houdailles F.
Sur les lois d'évaporation. Compt. rend., 1885, **100**:170–2.

Dalton's formula, $E=B\frac{F-f}{H}$, where E= evaporation from a unit surface in a unit of time, F= the vapor pressure at the surface of the liquid, f= the vapor pressure of the air, H= the atmospheric pressure, and B= a constant determined by the extent of the evaporating surface, is found not to apply to observations with the Piche evaporometer when the wind effect is considered. Confirms Dalton's discovery that evaporation from large evaporating surfaces is proportional to $F-f$. The evaporation in milligrams per hour per square centimeter from a surface of 13 cm² = 1.46 $(F-f)$, but the least agitation of the air alters the relation. Experiments show that an air current with a velocity of 0.25 meter per second raises evaporation from 4.4 to 13.8 milligrams per square centimeter per hour. Develops a formula for the Piche instrument.

Houdailles, F.
Sur l'évaporation dans l'air en mouvement. Comp. rend., 1885, **101**:428–31.

Shows that the temperature of the Piche atmometer is intermediate between that of the air and that of the wet-bulb thermometer. The rate of evaporation per square centimeter expressed in milligrams per hour, as determined by experiments with temperatures from 6° to 28°C., humidities from 42 to 82 per cent, and an air velocity of 9.0 meters per hour, is exactly given by the relation,

$$P=\frac{62\,(F-f)}{1+0.24\,(F-f)},$$

where P= the evaporation rate and $F-f$= the difference between the vapor pressure at the water surface and in the free air. Evaporation is greatly influenced by air movement up to a certain velocity, but beyond that it is but slightly affected. Evaporation, P, in a current of air of any velocity will be

$$P=\frac{p}{1+0.5V}+\frac{25.1\,(F-f)}{1+0.24\,(F-f)}\,(V+5\sqrt{V}),$$

where p = the evaporation in quiet air, and V= the wind velocity. A table compares calculated and observed evaporation at different wind velocities.

Jackson, Louis d'Aguilar.
Statistics of hydraulic works and hydrology of England, Canada, Egypt, and India. London. 1885. 8vo.

It is stated, p. 427, that the annual evaporation from Rajputana Tanks for the years 1882–3 was 8.4 feet where exposed to wind, and 4.8 feet where sheltered, the annual rainfall being 2 feet. On p. 455 he states that the amount of evaporation from Vahar Tank, north of Bombay, was 2.5 feet in the eight months of the dry season.

Sprung, A.
Lehrbuch der Meteorologie. Hamburg. 1885.

Discussion (p. 312–13) of the molecular physics of evaporation, and the conditions most favorable for it. In a mathematical discussion of the subject he quotes the formula devised by Weilenmann (1877). Quotes Chapman, 1855, and Ragona, 1867, on the relative evaporation from salt water and fresh water.

Symons, G. J.
Evaporation. Brit. rainf., 1885, (—):9.

Reports evaporation observations of the Strathfield Turgiss tank continued at Camden Square, where the tank is sunk 1 foot 8 inches in a grass plot. A table of observations accompanies the notice.

Tait, P. G.
On evaporation and condensation. Abstract in Proc. roy. soc. Edinb., 1885, **13**:91–5.

Discusses the necessity for condensation nuclei.

1886.

Chabaneix, J. B.
Mémoire sur l'évaporation du sol. Bul. mét. Hérault, 1886, (—): 84–94.

Shows that the cultivated soils evaporate less than the natural soils. Different soils present different ratios, varying from 0.75 to 0.48. In this bulletin are given curves of temperature, relative humidity, and daily evaporation. See Chabaneix, 1885, for description of method.

Fitzgerald, Desmond.
Evaporation. Trans. Amer. soc. civ. engin., 1886, **15**:581–645. Abstracts in Proc. inst. civ. engin., 1887, **88**:516–7; Sci. Amer. sup., 1886, **21**:8693–4; Van Nostrand's engin. mag., 1886, **35**:41–3; Amer. met. jour., 1889, **6**:7–8. Quoted by Rafter, 1903.

Defines the rate of evaporation as the difference between evaporation and condensation. Other things being equal, the difference between the temperature of the water and that of the dew-point determines evaporation. The principal points to be considered in a study of atmospheric aqueous vapor are: Temperature of the air, dew-point, vapor pressure, absolute and relative humidity, saturation deficit, and the weight of a cubic foot of air at the time of the observation.

Experiments upon the influence of heat on evaporation, E, gave

$$E=0.014\,(V-v)+0.0012\,(V-v)^2,$$

where V= vapor pressure of saturation at temperature of the water surface and v= prevailing vapor pressure of the air. In experiments to determine the influence of wind, the evaporating pans were moved into the open air and anemometers were placed at the level of the water in the pans. The formula for evaporation then becomes, w being the wind velocity in miles per hour:

$$E=[0.014\,(V-v)+0.0012\,(V-v)^2]\,(1+0.67\,w^{\frac{1}{2}}).$$

An approximate formula sufficiently accurate for most purposes is

$$E=\frac{(V-v)\,(1+\frac{1}{2}\,w)}{60}.$$

Concludes with Stelling and Daniell, that ordinary barometric changes are so slight that they can not materially affect the result. A large number of trials show that if observations are taken with sufficient accuracy and frequency very exact results may be obtained by use of the above formula, whether the experiments are conducted in the sun or shade.

Describes an instrument recording continuously air temperature, wind velocity, and evaporation, devised in 1884 and installed at the Chestnut Hill, Mass., reservoir. Records by this and other instruments show that the maximum evaporation does not occur on the hottest days, but may be expected on a cold day preceded by warm weather. Describes evaporation studies at Beacon Hill Reservoir, discusses evaporation in the winter, and reviews the work of Williams, Greaves, Miller, Dines, Latham, Field, Salles, and Wild. Regards measurements of the evaporation from small dishes not immersed in water as not even approximating the losses from a large body of water. (See Bigelow, 1907.)

Harreaux et Gruget.
La pluie et l'évaporation dans la Beauce. Bul. assoc. sci. de France, October 1886, (—): 58. Abstract in Ann. soc. mét., 1887, **35**:32.

Observations showed that from 1873–1877 the soil evaporation exceeded the rainfall; from 1877–1886 the soil received more water than it lost. Believes that springs are caused by an excess of rain over evaporation, and considers 1000 millimeters the excess necessary to so moisten the lower layers of soil that springs will flow.

Houdaille, F.
Marche comparée de la pluie et de l'évaporation aux divers mois de l'année. Ann. soc. mét., 1886, **34**: 191–2.

The dryness of a climate is expressed by $\frac{P-E}{E}$, in which P= the rain retained in the soil, E= the evaporation from soil and plants during an equal period. These are deduced from the rainfall, P', and the evaporation, E', as indicated by the Piche evaporometer. The monthly values of $\frac{P-E}{E}$ at Montpellier, for the decennial period, 1875–1884, show that the dry period commences in February, is interrupted in April, and finishes in August, the most humid month being January, and the driest July. In order more nearly to approach the value of P the rain intensity was studied with a recording rain gage. Derives a formula for the rate of evaporation from the Piche instrument.

Houdaille, [F.]
Marche annuelle de l'humidité du sol. Bul. mét. Hérault, 1886, (—): 53–64. Pl. 3.

Conclusions: (1) Evaporation from a soil depends on its physical properties, particularly on its clay content, on its faculty of imbibition, and the rate of capillary ascent of water in the dry soil. (2) In a soil possessing a high power of imbibition the variations of humidity at 0.5 meter depth have never exceeded one-fifth of the maximum water content, which has amounted to 19.1 per cent in clayey soil and to 15.9 per cent in less compact cal-

careous clay soil. (3) The date of minimum soil humidity has not been connected with a certain season, it results at once from the value of evaporation measured in the air and the length of the intervals of time which separate the consecutive rainfalls.

Marié-Davy, F. et H.
Évaporation du sol et des plantes. Jour. agr. prat., 1886, **1**: 857–8. Noticed in Forsch. Geb. Agr. Phys., 1888, **10**:66.

A brief note on the ratio of percolation to rainfall in case of enclosed masses of soil with and without vegetation. The amount evaporated is derived by subtraction.

Ragona, D.
Sul periodo diurno della evaporazione. Nota. Turin. 1886. 7 p.

Presents tables of precipitation, wind direction and velocity, temperature, and evaporation, observed every two hours in October, 1885, with pentad means. The calculated evaporation shows close agreement with measurements made with a micrometer gage. The calculated curve shows two maxima and two minima, occurring at equal intervals of 6 hours each. The principal maximum falls with the maximum temperature, but the principal minimum lags two to three hours behind the minimum temperature. The author considers that further experiments are necessary before accepting the secondary maximum and minimum.

Ragona, D.
Evaporazione comparata, etc. Ann. met. ital., 1886, parte I. Author's abstract in Met. Zeits., 1889, **6**: [31].

The evaporation in Mexico, in the shade, both observed and calculated, is compared with that at Modena. The rate is higher in Mexico from October to April, and lower from May to September. A comparison of the evaporation in the sun for both places shows similar differences in the rates. In both cases the rates for the two regions become equal toward the last of September and the last of April. The ratio between the evaporation in sun and shade was calculated, and a table compares the ratios obtained for Mexico and Modena. The annual curve of this ratio is shown to be identical with that of the relative humidity. The relation of the maximum and minimum to the spring equinox and the solstices is discussed.

Russell, Thomas.
Differences of still and whirled psychrometers. Mo. weather rev., 1886, **14**: 299–300.

Emphasizes statistically the need of active ventilation of the wet- and dry-bulb psychrometer.

Shidlovski, F.
Diffusion der Gase and Dämpfe durch poröse Körper. Jour. Russ. phys. chem. soc., 1886, **18**(6): 182–204. Abstract in Beibl. Ann. Phys. und Chem., 1887, **11**: 618–20.

Discusses the rate of the diffusion of vapor through a porous cylinder.

Symons, G. J.
On the evaporation from a water surface. Brit. rainf., 1886,(–): 14–17.

Describes the method of observing the evaporation from the large tank at Camden Square. A small still-well is made by means of a box, 4 by 4 by 12 inches, having a small hole in the bottom. By means of the hook-gage variations in the level can be read to 0.01 inch.

Teisserenc de Bort, Léon.
Météorologie. Rev. sci., 1886, **36**: 528–32.

Teisserenc de Bort, Léon.
L'évaporation. Résumé d'un travail de M. Ragona et des recherches plus récentes de M. Houdaille. Ciel et Terre, 1887, **2**: 510–12.

Review of Ragona, 1886, (1st title). Gives Houdaille's formula (see Houdaille, 1885, 3d title).

Venukoff.
Sur la vitesse de desséchement des lacs dans les climats secs. Compt. rend., 1886, **103**:1045. Abstract in Ann. soc. mét., 1887, **35**:18.

From the statement of the Russian explorer, Nicolski, that the level of Lake Balkash, (area about 19,000 square kilometers), is lowered 1 meter every fourteen or fifteen years, it is calculated that the amount of water annually evaporated must be 1,300,000,000 cubic meters, if none is lost underground. Under the influence of this rapid evaporation the southern part of the lake is gradually being transformed into a deposit of salt, as is also the case with the Caspian Sea, an already dry climate is becoming drier.

1887.

Chabaneix, J. B.
Mémoire sur l'évaporation du sol. Bul. mét. Hérault, 1887.

Continued from 1886.

Davis, W. M.
Water vapor and radiation. Amer. met. jour., 1887, **3**:443–4.

Discusses relation between size and speed of evaporation of water particles floating in the air.

de Touchimbert.
Observations météorologique faites à Poitiers en octobre et novembre, 1886. Ann. soc. mét., 1887, **35**:46.

The evaporation for October was 33 millimeters, for November, 26 millimeters.

Denza, P. Francesco.
Meteorologia Elementare di Roberto H. Scott. (Translation). Milan. 1887.

See Scott, 1887.

Harreaux.
Observations hydrométriques de la Beauce. Ann. soc. mét., 1887, **35**:242–7.

Compares the rates of evaporation from various surfaces under different exposures. Observations for the first three years showed an excess of evaporation equal to the cube of the rainfall for the same period; in 1876 rainfall and evaporation were equal; in the following years the rainfall exceeded the evaporation, and the levels of wells and streams rose accordingly. (See Harreaux et Gruget, 1886.)

Hauvel, Charles.
Du rôle de la vapeur d'eau dans l'atmosphère. Ann. soc. mét., 1887, **35**:6-7, 9-15.

Study of evaporation as influenced by the "atmospheric tide."

Hépites, S. C.
Evaporation de l'eau. Ann. inst. mét., Roumania, 1887, **3**:124–7.

Daily records of evaporation by Wild's recording evaporometer show two maxima for the year, 3.3 millimeters on May 21 and 3.1 millimeters on September 24. The total annual evaporation was 325.5 millimeters. Other tables show the monthly, seasonal, diurnal, and nocturnal rates. The ratio of the nocturnal to the diurnal rate was 3.53 in 1886 and 3.41 in 1887.

Klein, Hermann J.
Allgemeine Witterungskunde. Leipsic, Vienna, and Prague. 1887. p. 78–80.

General discussion of the laws and the methods of measuring evaporation.

Legras.
Sur un évaporomètre à température regulier. (Résumé par M. Teisserenc de Bort). Ann. soc. mét. 1887, **35**:241–2.

This atmometer is similar to the rain gages issued by the royal Belgian observatory to its meteorological stations It consists of an evaporating dish set into a much larger vessel, also containg water, and designed to reproduce the temperature and hygrometric conditions of a natural stream. Gives the evaporation for May, June, July, October, and November, 1886, as 59.6, 34.2, 34 7, 28.3, and 21.8 millimeters, respectively.

Milani, Gustavo.
Meteorologia popolare. Florence. 1887. p. 90–2.

Short discussion of the process and importance of evaporation.

Mohn, H.
Grundzüge der Meteorologie. Berlin. 1887. 4th ed.

See Mohn, 1875.

Murray, John
Rainfall and evaporation on the land surfaces of the globe. Abstracts in Scot. geog. mag., 1887, **3**:65–77; Met. Zeits., 1887, **4**:63; Forsch. Geb. Agr. Phys., 1888, **10**:457–9.

Evaporation is computed from the run-off and rainfall in different latitudes of the earth's surface, as follows:

Latitude.	Evaporation.	Rainfall.
°	*Mm.*	*Mm.*
50–60 N.	365	555
40–50 N.	510	745
30–40 N.	855	955
20–30 N.	805	940
10–20 N.	885	1,430
10 N.–10 S.	1,375	1,775
20–40 S.	951	1,225
Mean...	965	1,240

These are amounts of evaporation as related to temperature, humidity, and rainfall, while rainfall does not enter as a factor in the record of an evaporometer which shows only what would evaporate with a constant water supply. Estimates that not less than 87,000 cubic kilometers of water evaporate annually from the land surface of the globe.

Peek, Cuthbert E.
Evaporation experiments at Rousden Observatory, Devon, England. Amer. met. jour., 1887, **4**:2–3. Abstract in Quart. jour. roy. met. soc., 1887, **13**:242–3.

The evaporation from soil with turf and from water was measured by means of two similar tanks, 24 x 24 x 15 inches, freely exposed to the air, but protected from the sun's rays by a louvred wooden screen. The total annual evaporation from the soil was 24.79 inches, and from the water 22.81 inches.

Ritter, Charles.
Actions élémentaires dont dépend la croissance des nebules et des hydrométéorites. Ann. soc. mét., 1887, **35**:361–432.

History of earlier views of the formation of atmospheric vapor and discussion of the same from the modern point of view.

Scott, R[obert] H.
Elementary Meteorology. London. 1887. 4th ed. p. 95–103. (Translated by P. F. Denza, 1887. q. v.)

The process, effects, and importance of evaporation are discussed. The rainfall and evaporation on the earth's surface are believed to nearly balance each other.

Symons, G. J.
The Camden Square evaporation experiments. Brit. rainf., 1887, (–):38–9.

Results of measurements at the tank at Camden Square for 1887 and to June, 1888.

Warington, R.
A contribution to the study of well waters. Jour. chem. soc., 1887, **51**:52.

Considers the effect of vegetation in increasing evaporation from the soil.

Woeikof, Alexander.
Klimate der Erde. Jena. 1887. 2 vols.

Estimates annual evaporation from the Caspian Sea as 1090 millimeters. (Vol. 2, p. 265.)

Wollny, E.
Forstlich-meteorologische Beobachtungen. Forsch. Geb. Agr. Phys., 1887, **10**:415–46. Abstracts in Exp. sta. rec., 1895, **6**:197–9; Met. Zeits., 1896, **13**:362–4; also by Abbe, 1895.

An investigation of the rates of evaporation from different soil mulches. Conclusions: (1) The soil evaporates more water than the various mulches. (2) Of all the mulches experimented with, moss evaporates most, then follow oak leaves, beech leaves, fir and pine needles, with but small differences. (3) The thinner the mulch the greater the evaporation. (Continued in 1890.)

1888.

Abbe, Cleveland.
Treatise on meteorological apparatus and methods. Ann. Rpt. Chief Signal Officer for 1887, Pt. 2 (App. 46). Washington. 1888.

Discusses methods of measuring evaporation and of the temperature and rate of the same in connection with the hygrometric conditions of the air. Reviews work on vapor pressure and latent heat of vaporization by Ivory, Apjohn, Regnault, Glaisher, Kämtz, Wüllner, Stefan, Maxwell, Chistoni, Doyére, Angot, Sworykin, Pernter, and Ferrel. The observations by Fitzgerald and the formula derived by him are presented in detail.

Chabaneix, J. B.
Mémoire sur l'évaporation du sol. Bul. met. Hérault, 1888.

Continued from 1886 and 1887.

Greeley, A. W.
American Weather. New York. 1888. 8vo.

General discussion (p. 45–48) of the various classes of evaporometers.

Hann, J.
Beobachtungen über Verdunstung in der Kolonie New South Wales. Met. Zeits, 1888, 5:323.

Summarizes the results of observations of evaporation in New South Wales made by H. C. Russell in 1885. (See Symons, 1890.)

Müller-Erzbach, W.
Die Bestimmung der Durchschnittstemperatur durch das Gewicht von verdampfter Flüssigkeit. Met. Zeits., 1888, 5:453–9.

Determines the average temperature of the air by measuring the loss in weight through evaporation of various liquids. The results agree closely with the means of thermometer readings.

Russell, T[homas].
Depth of evaporation in the United States. Mo. weather rev., 1888, 16:235–9.

The evaporation from the Piche evaporometer was compared with that from a free water surface in a small dish, both dish and Piche being exposed in the standard louvred shelter of that date. The depth of evaporation recorded by the Piche and the average wind velocity at 19 different stations during June to September, 1888, are tabulated. Also determines the relative amounts lost by evaporation from stationary and whirling Piche for velocities of 10, 15, 20, 25, and 30 miles per hour. The rate of evaporation at Signal Service stations is then computed from the means of the tridaily readings of the wet-bulb and dew-point for the period December, 1887, to January, 1888, inclusive, using the following formula (no wind term is used because of the shelter exposure):

$$30\left(\frac{Ap_w + B(p_w - p_d)}{b}\right),$$

in which p_w=the vapor pressure for the mean monthly temperature of the wet-bulb thermometer, p_d=vapor pressure for the monthly mean dew-point, b=mean barometric pressure, A=1.96, and B=43.9. He compares these computed values with those observed at the Boston waterworks by Fitzgerald; and by means of them constructs a chart of lines of equal annual depth of evaporation at the U. S. Signal Service stations for the period July, 1887, to June, 1888.

Symons, G. J.
The Camden Square evaporation experiments. Brit. Rainf., 1888, (—):42–3.

Tables of evaporation from the large tank at Camden Square from July, 1888, to June, 1889, inclusive.

1889.

Campidoglio, R. Osservatorio del.
Osservazioni meteorologiche del R. Osservatorio del Campidoglio. Atti r. accad. Lincei, 1889, 5:(4).

The daily evaporation in millimeters and the monthly totals from January to July, 1889, show variations from 54.33 millimeters in February to 149.40 millimeters in July.

Carpenter, L. G.
Evaporation from tanks placed in the ground and also from tanks floating in the water. Colo. exp. sta. 2d Ann. Rpt., 1889, p. 49–76. Abstract in Exp. sta. rec., 1890, 2:394.

A table presents the monthly evaporation for the years 1887-9 at Fort Collins, Colo., from tanks 3 by 3 by 3 feet and also from smaller tanks to determine the influence of size and material on evaporation. The evaporation computed from the following expression differed only slightly from the observed amount: Evaporation in inches for 12 hours = $0.1934\,(T-t)(1+0.005\,w)$, in which T is the vapor pressure at the temperature of the water surface, t the vapor pressure of the air, and w the velocity of the wind in miles per 12 hours. For a whole day the formula becomes, $E=0.3868\,(T-t)(1+0.0025\,w)$. Fitzgerald's formula is quoted: E (24 hours) $=0.3984\,(T-t)(1+0.0208\,w)$. The close agreement of these coefficients, derived from investigations carried on under as different circumstances as these, strengthens confidence in either formula, and makes it probable that the true value of the coefficient is not far from 0.39 or 0.40. (See Bigelow, 1907.)

Davis, Walter G.
Ligeros apuntes sobre el clima de la República Argentina. Buenos Aires. 1889. p. 238–40.

Tables of evaporation from water in sun and shade, for the years 1886–1888, inclusive show an annual average of 2292.7 millimeters in the sun and 1169.6 millimeters in the shade. Comparative experiments on evaporation from a copper dish, a glass dish, and a Wild balance, gave in the sun 1320.7 millimeters for the first, 1088.5 millimeters for the second, and 1252.2 millimeters for the last; in the shade 648.8 millimeters for the first, and 624.1 millimeters for the last.

Demangeon, A.
Climatologie d'Épinal (Vosges). Résumé général pour 10 ans, de 1872 à 1881, des observations météorologiques faites à Épinal. Épinal. 1884. 2iéme. tirage, 1889.

This lithographed sheet, 10 by 16 inches, presents a table of monthly and annual means of all the meteorological elements, including observations with a psychrometer and a Piche evaporometer, extracted from the "Résumé général detaillé" published by the same author. The mean monthly and annual rainfall and vapor pressures at Épinal for the period 1872–81 are shown in the above table.

The evaporation is here omitted since the table gives no denomination for its figures.

[*To be continued.*]

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Rainf..	119.2	70.0	75.1	75.0	72.4	89.9	108.6	94.9	78.8	98.9	82.9	68.4	964.0
Vap. pr	4.83	5.19	5.86	6.45	7.52	10.52	12.09	11.75	9.56	7.53	5.84	4.94	7.68

METEOROLOGY IN THE SCHOOLS.

THE USE OF LANTERN SLIDES.

Many Weather Bureau officials are finding that more and more of their attention must be devoted to the educational calls being made upon them by the schools and the public generally. The writer knows of at least two who have already made quite a collection of lantern slides illustrating the lectures which they are frequently called upon to deliver. Probably a larger number have also made such collections. It will, therefore, be of interest to all such to read a very suggestive and instructive article by Prof. W. H. Hobbs[1] of the University of Michigan, wherein is described his method of classifying and storing lantern slides. The method used makes the course of lectures the primary base in the classification of the collection of slides. The slides are stored in unit boxes of japanned tin 3½ by 4 inches on the bottom and 3 inches deep, divided into front and rear halves by a tin partition. Each box holds sixteen slides in one half, the other half being reserved to receive the slides as they are removed from the lantern; and a box is expected to accommodate the slides illustrating a subdivision of a general topic, indicated by labels on the end of the box. Besides the slides these boxes also receive properly trimmed cards on which are entered lecture data, references to literature, etc., such as pertain to the subject of the slides in the same box; thus the lecturer has ready at hand both the illustrations and the references for the subjects on which he is lecturing.

THE WEATHER MAP AND THE SCHOOLS.

California is one of the States in the Union that takes the liveliest interst in the study and teaching and application of meteorology and climatology. Recent numbers of the Bulletin of the California Physical Geography Club bear witness to this interest and its practical expression. The number for March, 1909, contains descriptions of the courses at the San Rafael and San José high schools.

Mr. Percy E. Rowell, the instructor at the San Rafael High School, has perfected a very effective system of individual home observation and study in connection with the regular class work in the school. Each student procures a moderately accurate but cheap thermometer (price 25 cents) which he exposes "on the outside of the house toward the north." These individual thermometers are read daily and reported on, and "much interest has been aroused by the voluntary comparisons of weekly averages of temperature, and a little local pride has been stimulated in regard to places of greatest heat or least heat in winter and summer, respectively." The well equipped school observatory is in charge of a pair of pupils each week who make three observations daily, including Saturday, Sunday, and other holidays, compile the weekly record and publish a summary in a local newspaper over their own names. The whole class follow this work, keeping their records on appropriate forms and rendering duplicates to the teacher, who very properly emphasizes the fact that this routine work compels the pupil to attend to business, to *think of his work* even when he is not at school and studying. "It humanizes the science and makes it knowledge, not memory."

The San José High School also has a well equipped laboratory for physical geography. The present instructor, Miss Elizabeth McFadden, writes, "Our interest at present, in common with the general public, is in the weather. I constantly

[1] W. H. Hobbs: The use of lantern views with science lectures. The Journal of Geography, April, 1909, 7:180-6.

marvel at the universal prejudice with which the weather forecast is received. We are all keeping an accurate record of Professor McAdie's daily forecast for our valley, and ascertaining by direct observation how often he makes mistakes. We have found it very interesting *and we are all more loyal supporters of this department of the Government than before the experiment."—C. A. jr.*

WEATHER BUREAU METEOROLOGICAL CHARTS OF THE OCEANS.

In May, 1871, the U. S. Signal Service sent out its first circulars addressed to shipowners and captains, in which it was requested that regular and simultaneous (tridaily) meteorological observations be maintained on shipboard for the benefit of commerce and science. Lieut. M. F. Maury, U. S. N., had previously collected and plotted the data from a large number of ships' logs for the foundation of his work, "The Physical Geography of the Sea," and in 1876 the Secretary of the Navy ordered simultaneous meteorological observations to be made on all naval vessels, this being gradually extended to the merchant marine.

For a number of years the U. S. Hydrographic Office of the Navy Department has published pilot charts of the North Atlantic and North Pacific oceans, showing meteorological features based on data collected and prepared in part by that office and in part by the U. S. Weather Bureau; but from 1875 to 1887, inclusive, the data was furnished by the U. S. Signal Service.

In 1887 the U. S. Signal Service turned over the collection and tabulation of ocean meteorological observations to the Hydrographic Office, and that office continued, as previously, its publication of the means and normals prepared by the U. S. Signal Service, until July 29, 1904. In that year the Inter-Departmental Board, appointed by the President, recommended[1]

> That all meteorological reports from vessels of war or commerce or other sailing craft, now being forwarded direct to the Hydrographic Office of the Navy, shall be forwarded direct to the Weather Bureau, and the control of ocean meteorology be transferred to the Department of Agriculture, which already has ample law for doing that work;
>
> That the estimates for the support of the Hydrographic Office of the Navy, or any other office of the Navy, for the next and succeeding fiscal years, do not contain any provision for the making of ocean forecasts, or for the publication of meteorological data, other than such as may be needed by the Hydrographer of the Navy for use on the pilot and other charts, which data shall be furnished by and credited to the Weather Bureau.
>
> That it is the opinion of this Board that no meteorological work need or should be done by any portion of the Navy for the purpose of publication, or for the making of forecasts or storm warnings; that all such duties, being purely civil, should devolve upon the Weather Bureau of the Department of Agriculture in accordance with the organic act creating that Bureau.

The President approved this recommendation and by executive order the collection and tabulation of all meteorological data now published on the pilot chart of the Hydrographic Office has been prepared and furnished by the U. S. Weather Bureau.

Immediately on the resumption of this work by the Weather Bureau the entire meteorological data, pressure, temperature, wind-roses, storm tracks, gale percentages, calms, percentage of fog, trade wind limits, and the average conditions of wind and weather, for the North Atlantic and North Pacific monthly charts, were brought up to January 1, 1908; and this Bureau furnished in May, 1909, the first meteorological data for a seasonal pilot chart of the South Atlantic Ocean that has ever been issued by any Government.

From 1865 to 1887 the monthly reports received from vessels distributed over the principal marine highways of the globe was only 600, while at the present time, the greater interest in this branch of ocean meteorology has increased the number to over 2,000.

We take pleasure in drawing the attention of all our readers to the following notice recently issued by the Chief of the Marine Division of the Weather Bureau, relating to a new series of meteorological charts for the Atlantic and Pacific oceans.—*C. A. jr.*

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
MARINE DIVISION. *Washington, D. C., May 10, 1909.*

NOTICE.

Beginning with the month of July, 1909, meteorological charts of the North Atlantic and North Pacific oceans monthly, and South Atlantic Ocean quarterly, will be issued for distribution to cooperating shipmasters and others interested in ocean meteorology. The issue will include a seasonal chart of the South Pacific Ocean, September next.

The Bureau receives reports from 2,100 observers on vessels of every nationality, and from these reports prepares daily synoptic charts of the meteorological data, being thus enabled to plot the meteorological conditions prevailing over the oceans from day to day for the purpose of tracing storm tracks, percentage of fog, prevailing direction of wind, trade wind limits, pressure, and temperature.

There will be no charge for these charts. Some of them will be mailed direct from the Central Office to observers and captains on vessels, and others will be sent to American consuls and to branch Weather Bureau stations named on the list in form 1201—Marine, for distribution to such observers and captains as may not receive a copy from this office.

The Chief of the Weather Bureau would be pleased to receive from each captain or observer, on the inclosed card, a permanent address, preferably an address in the United States, to which the charts should be mailed each month.

The American representatives at the various ports are requested to kindly inform the Bureau as to the number of charts of each ocean that should be sent them for distribution to vessels touching at their ports.

It is the desire of the Chief of the Weather Bureau to popularize the charts and make them of benefit in a meteorological sense to those using them. With that end in view, any suggestion looking to their improvement will be appreciated.

Very respectfully, HENRY L. HEISKELL,
Chief of Division.

THE CUTHBERT, GA., TORNADO.

By C. F. VON HERRMANN, Section Director. Dated Atlanta, Ga., March 24, 1909.

The storm that did so much damage at Cuthbert, Randolph County, Ga., on the evening of March 9, 1909, seems to have been a veritable tornado. However, the night was so dark, with rain and wind, and the time of its passage so short that the funnel-shaped cloud was probably not actually observed by anyone. The storm was apparently not one of a group, but an isolated phenomenon formed under unusual conditions, though the center of the main barometric depression lay north of Chicago, Ill.

On the morning of March 9 a barometric depression of considerable depth was central near St. Louis, Mo., where the 7 a. m., central time, pressure was 29.34 inches. There was a peculiar trough or prolongation of low pressure that extended down the Mississippi Valley, or rather just east of the river, to New Orleans, La., where the pressure was 29.68 inches with southeast winds and a temperature of 72°. Meridian, Miss., reported a pressure of 29.64 inches and a temperature of 68°, while Vicksburg, Miss., just across the State had 29.72 inches, with a temperature of 50°, indicating sharp contrasts in temperature on each side of the trough of low barometer. At 7 p. m. the center of the depression had moved north of Chicago, Ill.; the trough of the low still extended south to the coast of the Gulf of Mexico, but had advanced to eastern Alabama. At 7 p. m. the temperature was 70° at Thomasville, Ga., with south winds, 62° at Atlanta, Ga., with southwest winds, but the wind had already shifted to west at Mobile and Montgomery, Ala., and the weather was clear at New Orleans, La., and Vicksburg, Miss. Thus the tornado occurred at the moment the trough of low pressure passed Cuthbert, Ga., and not in the southeast quadrant of the storm.

The track was not very long. It seems to have commenced

[1] See the article "Ocean Meteorology." Monthly Weather Review, 1904, 32:327.

just beyond the southwestern limits of the town. The tornado traveled from southwest to northeast and the path of greatest destruction averaged about 100 yards wide. The time was between 8:30 and 8:45 p. m. and the storm lasted about one minute. A roaring sound was heard and several correspondents reported that a funnel-shaped cloud was seen. The first damage was the blowing down of a barn on Mrs. Hood's place, about 1 mile from the western limits of the town. The path then extended diagonally across the southern and western portions of the city for a distance of a mile and it passed on toward Nochway. Six or seven miles beyond Cuthbert a barn and house were destroyed on the Northfield place. In the city itself the tornado left a line of wrecked houses, uprooted trees, and tangled telegraph wires, while merchandise and wreckage of all kinds covered its path. Evidence as to rotary motion by means of the position of fallen trees is doubtful. The loss of life was fortunately small; 5 persons were killed, about 13 were more or less seriously injured, and perhaps 300 were made homeless. The total loss is conservatively estimated at about $200,000.

A few of the peculiar effects of the storm may be mentioned. In a small grove of pine trees near the railroad track most of the trees were twisted off 10 to 12 feet from the ground. Fourteen box cars, some loaded with freight, standing on a side track were derailed. The Confederate Monument in Central Park was wrecked. The top of the standpipe was torn off, though it stood 200 yards outside of the path of the storm. The tornado swept the negro settlement and a part of the business section, but the residence district and the public buildings escaped.

On the same day at about 5 p. m. another tornado seems to have passed about 4 miles north of Big Creek in Forsythe County, in northern Georgia, over a path 200 yards wide; it came through Chamble Gap of Suwanee Mountain. It did considerable damage though no one was killed.

TORNADOES IN ALABAMA.

By F. P. CHAFFEE, Section Director. Dated Montgomery, Ala., February, 1909.

On February 5, 1909, two tornadoes passed over parts of Alabama.

The first began a few miles southwest of Hanceville, Cullman County, at 1:15 p. m., and lasted but a few minutes. The tornado cloud is described as having the appearance of a slender white column. Its path extended from southwest to northeast and averaged about 80 yards wide. One child was killed and twelve other persons were injured. The damage to property aggregated about $5,000.

The second tornado was more severe. It began about 3 miles southwest of Burkville, Lowndes County, about 4:30 p. m., and extended 10 miles into Montgomery County. It was accompanied by a funnel-shaped cloud. The average width of the path was about 150 yards. Near Burkeville one person was killed and two were injured. At this point six small frame houses were destroyed, their aggregate value being $1,800. At Stone's Plantation, about 9 miles west of Montgomery, where the greatest destruction was wrought, two persons were killed and about fifteen others were injured. At this point seven or eight houses and numerous farm implements were destroyed, the aggregate value of which was about $6,000.

The tin roof of one house at Stone's Plantation was ripped off and the tin wrapped about the limbs of an adjacent tree. Two bales of cotton, bound with six metal ties each, were also torn to pieces and scattered some distance to the northeast. At the same place a large manure spreader weighing over 1,000 pounds was also broken up and the heavy pieces carried for some distance.

On the afternoon of February 23, 1909, a tornado occurred near Tuscumbia, Colbert County, near the northwest corner of Alabama. This tornado began about 7 miles southwest of Tuscumbia, at 5:30 p. m. Its path, which was about 100 yards wide, extended a little over 1 mile from southwest to northeast, and the destructive winds accompanying the usual funnel-shaped cloud did serious damage. One person was killed, five frame buildings were destroyed, and other damage done.

SEVERE WINDS IN SOUTH CAROLINA.

J. W. Bauer, Section Director, Columbia, S. C., reports that on March 25, about 2:15 or 2:20 a. m., a severe and destructive windstorm traversed Greenwood and Newberry counties, S. C., but that the local reports do not confirm the statement that the storm was tornadic in character. Many trees were destroyed and buildings wrecked, and one person was reported killed. Some observers report that the storm was succeeded by a brilliant light as though reflected from clouds. In Columbia the luminous cloud was distinctly observed also. The station barograph at Columbia shows a quick jump of slightly more than 0.15 inch similar to the "nose" of a thunderstorm curve and unlike the downward curve characteristic of the pressure change accompanying a tornado.

TORNADOES IN TEXAS.

[Extracts from Monthly Climatological Reports, Texas Section, February and March, 1909.]

February, 1909.—A tornado, with well-defined pendant, funnel-shaped cloud, occurred at Center, Shelby County, Tex., at 5:30 a. m., February 5, 1909. It moved from southwest toward northeast. The path of greatest destruction was about one-fourth mile in width. The trees prostrated in the path of the storm were all lying in a northeasterly direction. The damage amounted to about $5,000, but there were no casualties.

A storm occurred at Liberty, Tex., at 3:30 p. m. February 18, 1909, moving from the southwest toward the northeast. The cloud was very dark and came like a whirlwind. It destroyed four buildings and then rose into the air, and descending again destroyed two more. The path of the storm was 30 feet wide. The damage is estimated at $3,000. One person was killed and five were injured.

Another storm occurred 7 miles southeast and south of San Augustine, Tex., about 2 p. m. February 18, 1909. It came from the southwest and went toward the northeast. The path of greatest destruction was 125 yards wide. Most of the trees on the north and south sides of the path were blown toward the center, while those in the center were lying both ways. Four houses were blown down; damage, $2,000. Stock loss was slight, as but few were in the path of the storm. One person was killed and four or five were slightly injured.

March, 1909.—Tornadoes, with well-defined pendant, funnel-shaped clouds, occurred on March 23, 1909, at Laredo, in Webb County, and at Crafton and Slidell, in Wise County.

The Laredo tornado occurred from 7:10 to 7:30 p. m. It came from the southwest and went toward the northeast. The path of greatest destruction was 500 yards in width. Trees in the center of the storm's path were prostrated in an easterly direction. The damage to buildings, livestock, and movable property is estimated at $75,000. One person was killed and fourteen were injured.

The Crafton tornado occurred between 9:45 and 10 p. m. The general direction of this storm was eastward, and the path of greatest destruction was about 80 yards in width. The damage to buildings is estimated at $ 5,000. There were no casualties, although a large number of buildings were either destroyed or badly damaged.

The Slidell tornado occurred at 10:15 p. m. It came from the west and went toward the northeast. The damage to buildings and movable property in the immediate vicinity of Slidell is estimated at $30,000. Eleven persons were killed and ten injured.—*B. Bunnemeyer.*

SLEET STORM IN OHIO.

[Extract from the Monthly Climatological Report, Ohio Section, February, 1909.]

A severe sleet storm occurred in the northern and middle sections of Ohio on February 14–16. The greatest damage was done in Hancock, Seneca, Erie, and Huron counties, where it was one of the worst sleet and ice storms ever experienced in Ohio.

The storm began as a mist or light rain, while the temperature of the air near the ground was from 5° to 10° below the freezing point, causing the precipitation to freeze to all objects on which it fell. This continued for nearly two days in many places, and finally changed to a damp, clinging snow, which added further weight to the already overloaded wires and trees. In some places the ice incrusting the telephone and telegraph wires was reported to be about 1 inch in diameter. At Fremont a section of telephone wire 4 feet long, coated with ice, weighed three pounds. At Tiffin a section 1 foot in length weighed one-half pound, while a small twig, with its ice covering, measured five inches in circumference.

The amount of precipitation for the entire storm was unusually heavy.

The damage to telegraph, telephone, and electric light wires, electric railways, fruit and shade trees was widespread. In many instances electric railways were unable to operate their cars for several days. Over 600 poles belonging to one company were broken down between Fremont and Norwalk, and 300 were broken between Findlay and Upper Sandusky. Telephone and telegraph communication was interrupted in the northwestern part of the State for nearly a week, and it required three months to repair the lines of that district.—*J. M. Kirk.*

TORNADOES IN MISSISSIPPI.

[Extract from the Monthly Climatological Report, Mississippi Section, February, 1909.]

In connection with severe thunderstorms on February 5, a tornado developed in northern Sharkey County, Miss., at about 9:30 a. m. The tornado moved in a northerly direction at Booth, where first observed, and later apparently changed its course to northeast when passing in the vicinity of Nittayuma, while in the vicinity of Murphy it moved from west to east. The width of the path varied from about 200 feet to one-fourth of a mile. The loss of life was confined to Booth, where five persons were killed. In the path of the storm, which was approximately 25 miles long, houses, cabins, barns, etc., were destroyed or damaged and some stock killed. Altogether about a dozen persons were more or less injured. Trees were blown down and some buildings slightly damaged for more than one-half mile on either side of the path of the storm. At Booth chickens were stripped of their feathers. The total property loss was probably somewhat less than $20,000. Heavy falls of hail were reported at a number of stations on the 5th.

On February 22 a tornado, moving from southwest to northeast, passed through the town of Falkner, Ripley County, Miss., at 8:10 a. m. Its path was from 200 to 400 yards in width. No lives were lost and no one was seriously injured, although two schoolhouses and a livery stable were blown down and eight houses were unroofed. Two horses were killed. The total property loss was estimated at $8,000.—*W. S. Belden.*

WATERSPOUTS ON THE ATLANTIC COAST.

Local press reports state that large waterspouts developed off Atlantic City, N. J., following a heavy blow on the afternoon of March 30. No casualties have been reported.

CORRIGENDA.

In the MONTHLY WEATHER REVIEW for January, 1909, p. 29, col. 1, line 30, for "mutual" read "natural;" on p. 42, col. 1, in the comparative table of rainfall in Jamaica the column "1908" should be "1909."

In the MONTHLY WEATHER REVIEW for February, 1909, p. 66, col. 2, line 3 from the bottom, for "Strömer" read "Störmer;" p. 60, col. 1, paragraph 2, line 1, and paragraph 3, line 8, for "Clayperon" read "Clapeyron;" p. 60, col. 2, footnote 4, for "1873, Marié-Davy, — title." read "1873, Marié-Davy, 1st title."

THE WEATHER OF THE MONTH.

By Mr. P. C. DAY, Acting Chief, Climatological Division.

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure for March, 1909, over the United States and Canada is graphically shown on Chart VI, and the average values and departures from the normal are shown for each station in Tables I and III.

The mean atmospheric pressure during March, 1909, was below the normal over all portions of the United States and Canada, except along the eastern slope of the Rocky Mountains and over the north Pacific coast and portions of British Columbia, where it was slightly above.

The mean pressure diminished rapidly from the Mississippi Valley eastward, the negative departures ranging from about —.05 over the first named locality to slightly more than —.20 inch over eastern New England and the Maritime Provinces of Canada, the mean for the month over the last-named district ranging from 29.80 to less than 29.70 inches. It was also below the normal by smaller amounts over the Plateau and south Pacific coast districts.

From February to March, 1909, there was an increase in pressure from the upper Mississippi Valley westward over the Missouri Valley and northern Plateau to the north Pacific coast, the increase over the latter district ranging from 0.10 to 0.20 inch.

Over the remaining districts of the United States there was a general decrease in pressure, being most pronounced along the Atlantic and Gulf coasts and over the Southwest, where the decrease ranged from 0.10 to nearly 0.20 inch.

With the highest average pressure over the upper Missouri Valley and a decided decrease in pressure to the eastward, northwesterly winds prevailed over most of the eastern districts, except along the Gulf coast, where they were largely from southerly points.

March, 1909, was a decidedly stormy month over the districts east of the Rocky Mountains, practically all portions coming under the influence of well-defined storm areas during some portion of the month.

There was a general excess of wind movement over the Atlantic and Gulf States, in the Lake region, and over the south Pacific coast. Over the Great Plains region and the northern portions of the Mountain, Plateau, and Pacific coast districts there was generally less wind than usual at that season of the year.

TEMPERATURE.

March, 1909, opened with moderate weather conditions prevailing over all districts, which continued till the morning of the 3d, when rain and snow set in over the Lake region, and during the following twenty-four hours developed into a storm of considerable severity, moving southeastward to the middle Atlantic coast by the morning of the 4th, and to the New England coast by the evening of the same date. Moderate weather

again prevailed over all districts until about the 8th, when a storm that had moved from the Pacific coast to southern Texas during the preceding two days developed considerable intensity and during the 8th, 9th, and 10th moved northeastward to the upper Lake region, accompanied by heavy rains over the Ohio and lower Mississippi valleys and heavy snows in portions of the lower Missouri and upper Mississippi valleys and Lake region. Following this area of heavy rain and snow cold weather set in over the Northwest on the morning of the 10th, and during the 11th to the 13th unusually cold weather prevailed over portions of the middle and southern slope and Rocky Mountain regions. Generally cold weather for the season, especially over the mountain region, prevailed from the 10th to the 24th, when a considerable rain and snow area covered the Plains region, and moving northeastward and eastward brought general rains and snows from the Mississippi Valley to the Atlantic coast by the morning of the 25th. Generally moderate temperatures, with considerable cloudy weather and frequent periods of light precipitation characterized the remainder of the month.

During the first decade the temperature averaged above the normal in practically all districts, the excess being most pronounced over the region between the Appalachian and Rocky Mountains, where the mean for the ten-day period ranged from 5° to 12° above the normal. During the second decade reverse conditions existed, and the mean temperature was generally below the normal in all districts, except along the Atlantic coast and at a few points in the Plateau and other districts. Over portions of the middle Mississippi and lower Missouri valleys and the southern portions of the Great Plains and Rocky Mountain regions the average temperature for this decade ranged from 4° to 8° below the normal. The average temperature for the third decade was below the normal in all interior districts, but was above the normal over the Gulf and North Atlantic States and along the northern border, where the normal was exceeded by from 3° to 6°.

As a whole the average temperature for the month was above the normal by small amounts along the immediate Atlantic coast, over the whole of the Gulf region, including the lower portions of the Ohio, Mississippi, and Missouri valleys, and by substantial amounts along the entire northern border from the Lake region to the Pacific. It was a decidedly warm month over the districts from North Dakota to eastern Washington, where the average ranged from 3° to more than 6° above the normal.

The extremes of temperature for the month were not unusual, the maximum temperatures ranging from less than 50° over the northern districts to 90° or above in the Rio Grande Valley and central Texas. Minimum temperatures of from 0° to —10° occurred at points in New England, Iowa, and Nebraska, in the vicinity of Lake Superior, over the northern portions of Minnesota, North Dakota, and Montana, and in the Rocky Mountain regions as far south as northern New Mexico. Temperatures of 32° or lower were recorded as far south as the central portions of the Gulf States, and generally over the western districts, except near the Pacific coast and at the lower elevations of California and Arizona.

PRECIPITATION.

The precipitation from the storm of the 8th to 10th was unusually heavy over portions of the lower Mississippi and Ohio valleys, in the southern Appalachian Mountain region and portions of the east Gulf States, and with the heavy rains of the 12th over portions of northern Georgia, central Alabama and surrounding districts caused high waters and some disastrous floods, especially in the streams of central Alabama and northern Georgia.

Aside from the above and some heavy falls of snow in the middle Atlantic coast district on the 4th and 5th and in the central and southeastern Rocky Mountain districts from the 7th to 11th, the precipitation occurred generally as light rain or snow well distributed during the month.

Precipitation was in excess of the average over the interior portions of the east Gulf States, at a few points in Maryland, Virginia, and northern New England, and generally over the Rocky Mountain region and the southern portions of Arizona and California.

Over the central and northern portions of Alabama and Georgia the excess ranged from 6 to 10 inches, and in portions of Colorado and southern Wyoming the excess ranged from 1 to more than 3 inches; the monthly fall in portions of southeastern Wyoming being especially heavy for that locality.

Over the remaining portions of the United States the precipitation was generally less than the average, the negative departures being quite pronounced over the eastern portions of Virginia and North Carolina, southern Florida, portions of North Dakota, Arkansas, Louisiana, and the greater part of Texas, where rain was badly needed at the end of the month. There was also a general lack of rainfall over the north Pacific coast especially in the western portions of Oregon and Washington.

SNOWFALL.

Snow in measurable quantities occurred in all portions of the United States, except over the South Atlantic and Gulf States, southwestern Arizona and along the coasts and at the low elevations of the Pacific coast States.

Unusually heavy snows occurred over portions of the Appalachian Mountains and Atlantic coast regions from Virginia northward on the 3d and 4th; the snow being unusually wet and heavy caused much damage to telegraph and telephone lines and seriously interferred with transportation and other interests in portions of Maryland and the adjoining States.

Heavy snows occurred over portions of the central and southern Rocky Mountain districts during the second week of the month.

In portions of New Mexico the fall was the heaviest in many years and with the severe cold following caused the loss of several human lives, and much suffering to sheep and cattle unprotected from the inclement weather.

In portions of Colorado and Wyoming the snowfall was also unusually heavy, especially in the mountains of southern Wyoming where the amounts were greater than ever known in March.

Over the remaining portions of the Mountain and Plateau districts the snowfall was about average, except over most of Idaho and Washington where the amounts were generally very light.

At the end of the month the snow had disappeared from all portions of the United States, except the more northern districts and in the mountain regions of the west.

In portions of northern New England and the mountain districts of New York, the depths in the woods ranged from 2 to 3 feet, but in the open fields it had largely disappeared. In the northern Peninsula of Michigan deep snow still covered the ground at the end of the month and there was a considerable depth in the northern portions of Wisconsin, Minnesota, and North Dakota, with smaller amounts as far south as northern Iowa and central Nebraska.

In the mountain regions of the West the snow had disappeared from the lower elevations but in the higher ranges it had melted but little, due to the generally cool weather, and the accumulated stock at the end of the month was generally greater than at the same time in many years It had been largely drifted into the ravines and protected parts of the mountains, was generally well packed and hard frozen, possessed a large water content, and was generally reported in such conditions as to assure an abundant supply of water during the warmer portions of the year.

HUMIDITY AND SUNSHINE.

The average relative humidity was above the normal over southern Florida, the lower Lake region, and from the upper Lakes westward and southwestward over the upper Missouri Valley, Rocky Mountain and Plateau districts, and south Pacific coast. In the southern Plateau and mountain regions the excess was from 10 to 21 per cent. Over all other portions of the country the average ranged from normal to 15 per cent below.

There was an excess of cloudiness over nearly all of the country, except along the Atlantic and part of the Gulf coasts, and from the upper Missouri Valley westward over Idaho and Washington to the Pacific coast. Over the Lake regions, the Ohio, upper Mississippi and Missouri valleys, the sunshine ranged from 26 to 40 per cent of the possible.

In Canada.—Director R. F. Stupart says:

The mean temperature for March was generally above the average in Canada, although in portions of British Columbia, the major part of Ontario and over Quebec, the normal value was either not quite or just reached. Departures from average in the Western Provinces ranged between 2° and 8°.

The precipitation recorded in Canada during March was less than the usual quantity, except over a large portion of Ontario, eastern Quebec, and the Maritime Provinces, where the normal amount was slightly exceeded.

On the last day of the month the ground over a large portion of Canada was snow covered. In British Columbia the higher levels were well covered; also the northern districts of Alberta. In Saskatchewan and Manitoba there was a depth of from 3 to 7 inches. Northern Ontario recorded from 5 to 11 inches; elsewhere in the province the ground was practically bare. A depth of 16 inches at Montreal increased eastward to 52 inches at Quebec. New Brunswick was also largely snow covered, the depth decreasing rapidly southward to a trace near the Bay of Fundy.

Average temperatures and departures from the normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since January 1.	Average departures since January 1.
		°	°	°	°
New England	12	33.1	+ 0.2	+ 5.3	+ 1.8
Middle Atlantic	16	40.2	— 0.1	+10.0	+ 3.3
South Atlantic	10	54.1	+ 0.3	+ 9.5	+ 3.2
Florida Peninsula*	8	67.6	+ 0.8	+11.8	+ 3.9
East Gulf	11	58.6	+ 1.4	+ 8.6	+ 2.9
West Gulf	10	58.8	+ 1.5	+10.4	+ 3.5
Ohio Valley and Tennessee	13	43.9	— 0.5	+ 9.6	+ 3.2
Lower Lake	10	31.6	— 0.7	+ 8.2	+ 2.7
Upper Lake	12	28.8	+ 1.5	+ 8.3	+ 2.8
North Dakota*	9	23.9	+ 3.4	+ 4.5	+ 1.5
Upper Mississippi Valley	15	35.9	— 0.1	+ 8.9	+ 3.0
Missouri Valley	12	37.0	+ 0.9	+ 9.0	+ 3.0
Northern Slope	9	32.4	+ 1.6	+ 3.7	+ 1.2
Middle Slope	6	41.6	— 0.9	+ 6.8	+ 2.3
Southern Slope*	7	52.3	— 0.2	+ 8.8	+ 2.9
Southern Plateau*	12	45.6	— 3.8	— 0.8	— 0.3
Middle Plateau*	10	36.8	— 1.1	+ 5.4	+ 1.8
Northern Plateau*	12	40.4	+ 2.5	+ 4.8	+ 1.6
North Pacific	7	44.2	0.0	— 3.0	— 1.0
Middle Pacific	8	50.5	— 2.0	+ 1.1	+ 0.4
South Pacific	4	53.0	— 2.1	+ 0.2	+ 0.1

* Regular Weather Bureau and selected cooperative stations.

Average relative humidity and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	71	— 4	Missouri Valley	72	0
Middle Atlantic	69	— 3	Northern Slope	69	+ 2
South Atlantic	71	— 4	Middle Slope	65	+ 5
Florida Peninsula	78	+ 1	Southern Slope	53	— 2
East Gulf	71	— 2	Southern Plateau	49	+10
West Gulf	68	— 4	Middle Plateau	59	+ 5
Ohio Valley and Tennessee	70	— 1	Northern Plateau	64	— 3
Lower Lake	78	+ 2	North Pacific	80	+ 1
Upper Lake	79	0	Middle Pacific	75	— 3
North Dakota	86	+ 6	South Pacific	72	+ 1
Upper Mississippi Valley	74	+ 1			

Average precipitation and departures from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
		Inches.		Inches.	Inches.
New England	12	3.09	82	— 0.7	+ 1.5
Middle Atlantic	16	2.95	81	— 0.7	— 1.2
South Atlantic	10	3.66	79	— 1.0	— 3.8
Florida Peninsula*	8	2.52	81	— 0.6	— 3.2
East Gulf	11	7.07	120	+ 1.2	— 0.6
West Gulf	10	1.94	62	— 1.2	— 4.4
Ohio Valley and Tennessee	13	3.83	85	— 0.7	+ 1.0
Lower Lake	10	2.65	100	0.0	+ 2.0
Upper Lake	12	1.45	64	— 0.8	— 0.4
North Dakota*	9	0.30	30	— 0.7	— 1.1
Upper Mississippi Valley	15	1.90	79	— 0.5	+ 0.7
Missouri Valley	12	1.23	64	— 0.7	— 0.2
Northern Slope	9	1.02	91	— 0.1	— 0.1
Middle Slope	6	1.64	114	+ 0.2	— 0.3
Southern Slope*	7	1.55	124	+ 0.3	— 1.3
Southern Plateau*	12	0.84	89	— 0.1	— 0.2
Middle Plateau*	10	0.87	64	— 0.5	+ 0.7
Northern Plateau*	12	0.84	62	— 0.5	+ 0.7
North Pacific	7	2.72	55	— 2.2	+ 1.6
Middle Pacific	8	3.08	81	— 0.7	+ 9.8
South Pacific	4	2.59	100	0.0	+ 6.8

* Regular Weather Bureau and selected cooperative stations.

Average cloudiness and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	5.4	— 0.2	Missouri Valley	5.2	— 0.4
Middle Atlantic	5.5	0.0	Northern Slope	5.0	— 0.3
South Atlantic	4.9	+ 0.2	Middle Slope	5.4	+ 1.0
Florida Peninsula	3.5	— 0.5	Southern Slope	4.4	+ 0.2
East Gulf	5.3	+ 0.6	Southern Plateau	3.5	+ 0.5
West Gulf	4.8	— 0.4	Middle Plateau	4.9	0.0
Ohio Valley and Tennessee	6.3	+ 0.4	Northern Plateau	5.8	— 0.7
Lower Lake	6.6	+ 0.2	North Pacific	6.5	— 0.1
Upper Lake	6.4	+ 0.3	Middle Pacific	5.3	+ 0.3
North Dakota	5.9	+ 0.4	South Pacific	4.6	+ 0.1
Upper Mississippi Valley	6.2	+ 0.7			

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Amarillo, Tex.	24	60	nw.	Mount Weather, Va.	26	64	nw.
Atlanta, Ga	3	58	nw.	Do	31	51	nw.
Do	24	66	nw.	Nantucket, Mass	4	55	ne.
Block Island, R. I.	4	62	ne.	Do	25	54	se.
Do	5	50	w.	New York, N. Y.	5	56	w.
Do	11	52	w.	Do	10	52	w.
Do	25	56	se.	Do	11	60	w.
Buffalo, N. Y.	10	68	sw.	North Head, Wash.	1	68	s.
Cheyenne, Wyo.	1	50	w.	Do	8	54	nw.
Cleveland, Ohio	9	54	s.	Do	29	56	se.
Columbus, Ohio	4	50	nw.	Do	30	68	se.
Detroit, Mich.	10	50	w.	Oklahoma, Okla.	23	50	s.
El Paso, Tex.	7	54	w.	Do	24	56	sw.
Do	23	60	w.	Point Reyes Light, Cal.	5	58	s.
Do	28	52	w.	Do	7	64	nw.
Fort Worth, Tex.	24	52	w.	Do	8	79	nw.
Galveston, Tex.	8	53	se.	Do	9	79	nw.
Hatteras, N. C.	3	52	w.	Do	17	74	nw.
Do	25	58	nw.	Do	19	64	nw.
Mount Tamalpais, Cal	7	64	nw.	Do	20	52	s.
Do	8	75	nw.	Portland, Me.	25	56	e.
Do	9	62	nw.	Pueblo, Colo	26	50	w.
Do	10	50	n.	Southeast Farallon, Cal.	8	54	n.
Do	19	53	nw.	Do	9	60	n.
Do	20	66	nw.	Do	17	55	n.
Do	29	66	w.	Do	18	51	n.
Mount Weather, Va.	4	75	nw.	Syracuse, N. Y.	11	54	w.
Do	5	54	nw.	Tatoosh Island, Wash.	1	52	sw.
Do	10	53	nw.	Do	6	54	ne.
Do	11	59	nw.	Do	30	52	s.
Do	25	78	nw.	Toledo, Ohio	10	58	sw.

CLIMATOLOGICAL SUMMARY.

By Mr. P. C. DAY, Acting Chief, Climatological Division.

TEMPERATURE AND PRECIPITATION BY SECTIONS, MARCH, 1909.

In the following table are given, for the various sections of the Climatological Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting greatest and least monthly precipitation, and other data, as indicated by the several headings.

The mean temperatures for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperature and precipitation are based only on records from stations that have ten or more years of observation. Of course the number of such records is smaller than the total number of stations.

Section.	Temperature—in degrees Fahrenheit.								Precipitation—in inches and hundredths.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
Alabama	56.0	0.0	Ozark	89	8	Oneonta	25	16	9.02	+ 3.20	Montgomery	16.51	Spring Hill	2.03
						Valley Head	25	4 d't's						
Arizona	50.4	— 3.7	Mohawk Summit	96	22	Flagstaff, A	0	24	1.38	+ 0.32	Chlarsons Mill	4.44	Mohawk Summit	0.14
Arkansas	52.7	+ 0.2	Lewisville	84	2	Bergman	16	15	3.71	— 1.45	Warren	6.28	Dutton	1.65
			McNeil	84	2	Dodd City	16	15						
California	48.5	— 2.4	Blythe	90	31	Fordyce Dam	4	7	3.56	— 0.64	Magalia	12.77	Mojave	0.00
Colorado	33.2	— 1.5	Hoehne	83	1	Wagon Wheel Gap	—27	12	1.53	+ 0.51	Corona	8.26	Delta, River Portal	T.
Florida	66.2	+ 0.2	6 stations	92	6 d't's	Live Oak	30	1	2.96	— 0.34	Fenholloway	7.30	Sand Key	0.15
Georgia	56.0	+ 0.3	Blakely	89	28	Diamond	21	16	8.66	+ 2.80	Gore	12.85	Blakely	1.39
			Valdosta	89	7									
Hawaii (February)	67.3	.....	Kihei, Maui	88	19	Humuula, Hawaii	34	2	6.32	.....	Honokane, Kauai	22.62	Kekaha, Kauai	0.93
Idaho	37.7	+ 2.0	Dent	74	23	Chesterfield	—16	12	0.98	— 1.04	Oro Fino	2.93	Payette	0.13
Illinois	39.5	— 0.1	Mascoutah	73	2	Lanark, Zion	5	17	2.31	— 0.95	Cairo	7.10	Antioch	0.60
Indiana	40 0	0.0	Jeffersonville, Rome	70	19	3 stations	10	17	2.88	— 0.97	Rome	6.06	South Bend	1.66
Iowa	32.5	— 1.5	St. Charles	71	23	3 stations	—15	17	1.53	— 0.39	Perry	5.00	Denison	0.28
Kansas	42.1	— 0.5	Kingman	86	3	Hugoton	— 3	12, 13	1.89	+ 0.29	Le Roy	3.68	McPherson	0.46
Kentucky	44.7	— 1.5	Middlesboro	74	9	Scott, Williamstown	17	17	5.26	+ 0.25	Alpha	8.33	Scott	3.22
Louisiana	61.2	+ 0.2	3 stations	90	28, 29	Robeline	26	15	3.54	— 1.36	Amite	7.30	Burrwood	0.81
Maryland and Delaware	40.4	— 1.7	Cambridge, Md	80	10	Deer Park, Md	9	23	3.70	— 0.02	Annapolis, Md	5.82	Cumberland, Md	1.75
Michigan	29.2	— 0.3	Clinton	69	28	Ewen	—24	5	1.75	— 0.62	Blaney	4.10	West Branch	0.35
Minnesota	26.1	+ 1.0	3 stations	59	23	Bagley	—26	17	0.54	— 0.82	Grand Meadow	2.00	St. Peter	T.
Mississippi	57.6	— 0.2	Natchez	86	6	Ripley	27	4	5.80	— 0.11	Agricultural College	12.68	Woodville	1.79
			Leakesville	86	29	University	27	15						
Missouri	44.5	+ 0.3	Warsaw	81	23	Unionville	9	17	3.07	— 0.39	Sikeston	6.97	Warrensburg	0.60
Montana	32.2	+ 2.9	Raymond	70	18	Bowen	—35	11	0.96	— 0.03	Virginia City	3.76	3 stations	T.
Nebraska	35.0	— 0.4	Beaver City	80	24	Fort Robinson	—15	8	0.98	— 0.11	2 stations	2.60	2 stations	T
						Hay Springs								
Nevada	38.8	+ 0.1	Logan	80	15	Halleck	—10	11	0.67	— 0.65	Palmetto	1.43	Humboldt	T.
New England*	31.2	+ 0.3	Norwalk, Conn	61	10	Van Buren, Me	—22	1	3.36	— 0.45	Bar Harbor, Me	5.85	St. Johnsbury, Vt	0.72
			Waterbury, Conn	61	10									
New Jersey	38.3	— 0.7	3 stations	74	10	Layton	— 6	6	3.48	— 0.53	Trenton	4.66	Culvers Lake	2.31
New Mexico	41.6	— 3.1	Monument	90	26, 28	Rociada	—17	12	1.20	+ 0.23	Mountain Air	4.92	Monument	T.
New York	29.4	— 1.6	New York City	66	10	Gabriels	—20	21	2.85	— 0.52	Morehouseville	5.88	Hemlock Lake	0.74
North Carolina	49.1	— 1.4	Fayetteville	84	9	Mount Airy	15	16	3.35	— 1.41	Sunburst	11.29	Wilmington	0.89
North Dakota	24.1	+ 3.2	Orange	61	25	Cando	—24	17	0.32	— 0.61	Bottineau	2.57	Portal	0.00
						Hansboro	—24	16						
Ohio	37.2	— 1.9	Ironton, Portsmouth	70	19	Bucyrus	6	17	2.76	— 0.77	New Alexandria	4.78	Waynesville	1.76
						Green Hill	6	18						
Oklahoma	49.5	— 1.2	Temple	91	5	Kenton	— 6	12	1.83	— 0.45	Hartshorne	3.80	Supply	0.12
Oregon	44.2	+ 1.6	Toledo	78	15	Range	— 4	5	2.26	— 2.37	Gold Beach	9.75	Prineville	T.
Pennsylvania	35.6	— 1.8	Hanover	74	10	Pocono Lake	— 5	6	3.07	— 0.75	Indiana	4.90	Everett	1.33
Porto Rico	75.0	+ 1.0	3 stations	95	3 d't's	Cayey	49	1	2.39	— 6.86	Canovanas	6.82	Guanica Central	0.19
South Carolina	54.1	— 0.8	Allendale	90	9	3 stations	27	4, 5	4.80	+ 0.63	Jacksonboro	10.06	Dillon	1.54
South Dakota	30.9	+ 1.3	Ottumwa	75	23, 25	Cascade Springs	— 9	8	0.34	— 0.88	Vermillion	1.05	6 stations	T.
Tennessee	49.5	+ 0.2	Dyersburg	81	26	Rugby	16	5	5.34	— 0.54	Newport	8.45	Dyersburg	2.60
Texas	59.5	+ 2.0	Zapata	103	27, 28	Dalhart	0	12	1.08	— 1.14	Hillsboro	4.35	2 stations	0.00
						Plemons	0	13						
Utah	37.4	— 1.2	St. George	78	15	Scofield	—21	11	1.16	— 0.28	Henefer	3.53	Green River, Wellington.	0.00
Virginia	43.6	— 1.8	Doswell	82	10	Blacksburg	11	4	3.44	— 0.59	Warsaw	7.98	Cape Henry	1.20
Washington	43.3	+ 1.4	Mottinger's Ranch	76	16	Northport	7	7	2.05	— 1.14	Quinlault	11.23	Tieton	0.00
			Zindel	76	31									
West Virginia	40.8	— 3.0	Logan	83	9	Arbovale	10	16	3.38	— 0.76	Princeton	8.66	Valley Fork	1.10
Wisconsin	28.6	— 0.3	Grand River Locks	58	31	Long Lake	—22	5	1.21	— 0.77	Chilton	2.68	Solon Springs	0.31
Wyoming	29.3	— 0.1	Gillette	67	17	Lake Yellowstone	—29	11	1.03	— 0.02	Granite Canyon	5.33	Basin	T.
			Tensleep	67	23, 25									

* Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

DESCRIPTION OF TABLES AND CHARTS.

By Mr. P. C. DAY, Acting Chief, Climatological Division.

For description of tables and charts see page 34 of REVIEW for January, 1909.

TABLE I.—*Climatological data for U. S. Weather Bureau stations, March, 1909.*

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.								Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.					
New England.							33.1	+ 0.2									71	3.09	— 0.7										5.4	
Eastport	76	67	85	29.61	29.70	— .23	30.3	+ 1.4	45	29	36	— 8	1	24	23	28	24	78	5.10	+ 0.8	15	9,586	w.	43	e.	17	7	10	14	6.4	14.8
Greenville	1,070	6	....	28.55	29.75	.....	23.7	.....	43	27	34	— 6	16	13	42	.....	.....	.....	4.76	.....	12	.....	nw.	.....	.....	.....	.....	.....	.....	.....	.....
Portland, Me.	103	81	117	29.64	29.77	— .19	31.6	— 0.4	48	31	38	10	1	25	19	28	22	70	2.76	— 1.0	12	8,001	nw.	56	e.	25	13	9	9	5.0	6.2
Concord	288	70	79	29.45	29.77	— .23	31.8	+ 0.3	52	27	40	10	1	24	30	.....	.....	.....	2.56	— 0.8	11	5,333	nw.	41	e.	25	16	9	6	4.0	8.7
Burlington	404	11	48	29.35	29.81	— .19	26.8	— 0.5	48	10	35	1	1	19	27	.....	.....	.....	1.81	0.0	12	7,857	nw.	48	se.	25	6	14	11	6.1	14.1
Northfield	876	16	70	28.83	29.81	— .19	24.4	— 1.8	47	10	34	— 6	1	15	33	22	19	78	1.85	— 0.9	12	6,112	nw.	31	s.	24	8	10	13	6.1	20.0
Boston	125	115	188	29.64	29.78	— .19	36.8	+ 1.8	55	27	44	17	1	30	22	32	25	66	3.28	— 0.8	12	9,418	nw.	40	se.	25	13	5	13	5.7	3.1
Nantucket	12	14	90	29.76	29.77	— .21	36.7	— 0.1	51	10	42	24	6	32	19	34	30	79	3.34	— 0.6	14	12,979	w.	55	ne.	4	14	7	10	5.4	T.
Block Island	26	11	46	29.76	29.79	— .19	36.5	+ 0.6	51	10	41	23	1	32	18	33	28	73	2.60	— 1.8	11	16,090	w.	62	ne.	4	16	3	12	4.8	T.
Narragansett	.....	9	.....	.....	.....	.....	35.9	+ 0.9	58	31	45	17	1	27	27	.....	.....	.....	2.71	.....	11	.....	w.	.....	.....	.....	15	5	11	.....	0.5
Providence	160	141	165	29.62	29.80	— .17	35.4	— 0.3	57	10	43	18	1	28	25	31	24	64	2.86	— 1.2	13	10,192	nw.	48	se.	25	11	10	10	5.6	3.5
Hartford	159	122	140	29.64	29.82	— .18	35.0	0.0	55	25	42	17	1	28	26	30	24	68	3.64	— 0.7	12	6,794	nw.	46	e.	25	12	7	12	5.7	8.6
New Haven	106	116	155	29.70	29.82	— .17	36.5	+ 1.1	55	31	44	19	1	30	22	31	24	64	4.20	— 0.2	13	7,963	nw.	44	e.	25	13	6	12	5.1	6.7
Mid. Atlantic States.							40.2	— 0.1									69	2.95	— 0.7										5.5	
Albany	97	102	115	29.73	29.84	— .17	32.9	+ 0.8	51	28	40	14	1	26	20	29	24	72	2.11	— 0.6	11	6,834	nw.	48	e.	25	9	13	9	5.3	10.3
Binghamton	871	78	90	28.88	29.83	— .19	31.0	— 1.0	60	10	39	4	6	24	36	.....	.....	.....	2.45	— 0.2	11	6,259	w.	30	w.	17	5	7	19	7.4	15.3
New York	314	108	350	29.48	29.83	— .17	38.3	+ 0.8	66	10	45	21	5	32	28	35	26	65	3.19	— 0.9	11	12,344	w.	60	w.	11	12	10	9	5.2	4.1
Harrisburg	374	94	104	29.47	29.88	— .15	38.0	+ 0.2	65	10	45	22	6	31	28	33	26	65	2.82	— 0.3	14	7,384	w.	40	w.	10	9	11	11	5.8	8.0
Philadelphia	117	116	184	29.75	29.88	— .14	41.4	+ 1.4	71	10	48	25	5	34	29	36	30	67	2.92	— 0.5	13	8,944	nw.	36	n.	4	12	9	10	5.2	4.7
Scranton	805	111	119	28.98	29.86	— .16	34.0	— 0.9	61	10	42	8	6	26	31	30	25	72	2.68	— 0.4	16	6,943	nw.	38	sw.	10	8	9	14	6.6	13.0
Atlantic City	52	37	48	29.80	29.86	— .16	39.3	+ 0.5	57	10	46	23	5	32	21	36	30	71	3.58	— 0.2	14	7,378	nw.	43	ne.	4	11	9	11	5.6	0.3
Cape May	17	48	52	29.88	29.90	— .11	40.8	0.0	62	10	46	26	22	35	17	37	.....	.....	3.34	— 0.4	13	8,666	nw.	38	ne.	4	8	15	8	5.4	2.0
Baltimore	123	100	113	29.76	29.89	— .14	41.8	— 0.1	74	10	49	24	5	34	31	37	31	68	4.58	+ 0.7	13	6,169	nw.	30	sw.	25	10	8	13	6.3	11.7
Washington	112	62	76	29.77	29.89	— .15	42.1	— 0.1	75	10	51	26	22	34	35	36	29	63	4.76	+ 0.9	14	7,198	nw.	42	nw.	25	8	10	13	5.8	10.8
Cape Henry	18	9	58	29.88	29.90	— .13	47.1	+ 0.5	76	9	54	32	5	40	31	.....	.....	.....	1.20	— 3.1	11	11,678	nw.	48	w.	3	13	9	9	4.5	T.
Lynchburg	681	83	88	29.16	29.92	— .13	45.0	— 0.4	70	10	55	24	22	35	36	39	34	70	2.37	— 1.4	12	4,433	nw.	30	nw.	4	11	11	9	5.4	4.5
Mount Weather	1,725	10	54	28.00	29.87	— .18	36.5	— 0.3	68	10	45	19	22	28	32	32	26	70	1.88	— 2.1	14	15,074	nw.	78	nw.	25	10	8	13	5.3	2.4
Norfolk	91	102	111	29.81	29.91	— .12	48.1	— 0.4	75	9	56	32	5	40	29	42	36	68	1.35	— 2.9	8	8,125	s.	42	w.	25	10	12	9	4.8	T.
Richmond	144	145	153	29.76	29.92	— .12	46.4	— 0.5	77	10	56	27	22	36	29	.....	.....	.....	4.13	+ 0.4	12	7,669	nw.	46	sw.	25	14	8	9	4.7	3.8
Wytheville	2,293	40	47	27.51	29.93	— .12	40.9	— 1.4	70	9	50	29	16	32	32	36	33	81	3.81	— 0.6	17	5,775	w.	32	w.	3	13	10	8	4.5	1.2
S. Atlantic States.							54.1	+ 0.3									71	3.66	— 1.0										4.9	
Asheville	2,255	53	75	27.55	29.94	— .12	44.7	— 0.2	67	27	55	25	16	35	33	39	35	75	5.05	0.0	15	7,656	nw.	37	nw.	4	12	5	14	5.5	0.3
Charlotte	773	68	76	29.09	29.94	— .11	49.8	— 1.0	78	9	59	32	15	41	30	44	37	67	2.86	— 1.7	13	6,356	s.	38	w.	25	11	7	13	5.6	
Hatteras	11	12	47	29.90	29.91	— .13	52.2	+ 0.8	69	9	58	37	24	46	25	48	45	80	1.80	— 3.7	11	11,754	sw.	58	nw.	25	16	9	6	4.4	
Manteo	.....	.....	.....	.....	.....	.....	51.0	.....	72	10	58	31	19	42	.....	.....	.....	.....	2.29	— 2.8	11	.....	n.	.....	.....	.....	19	5	7	.....	
Raleigh	376	103	109	29.51	29.93	— .12	48.8	— 1.6	78	9	59	31	18	39	32	42	34	62	2.77	— 1.5	12	7,395	nw.	49	nw.	25	9	11	11	5.3	
Wilmington	78	81	91	29.86	29.94	— .11	53.9	+ 0.2	75	9	63	33	5	45	25	47	42	70	0.89	— 2.7	9	7,004	sw.	41	sw.	25	10	15	6	4.6	
Charleston	48	14	92	29.89	29.94	— .12	58.1	+ 0.9	77	7	66	41	4	50	26	51	47	74	5.89	+ 2.2	13	8,446	sw.	39	s.	25	12	8	11	5.0	
Columbia, S. C.	351	41	57	29.55	29.93	— .13	54.4	+ 0.4	83	9	64	32	16	44	30	46	39	64	3.47	— 0.2	12	6,198	sw.	40	sw.	25	8	11	12	5.8	
Augusta	180	89	97	29.73	29.94	— .12	55.8	+ 0.1	84	9	66	33	16	46	30	48	42	68	5.64	+ 0.8	10	5,591	nw.	46	nw.	25	11	9	11	5.1	
Savannah	65	81	89	29.89	29.96	— .10	59.7	+ 1.4	80	7	68	41	5	51	27	52	47	73	5.38	— 1.7	12	6,212	sw.	37	w.	3	13	8	10	4.6	
Jacksonville	43	96	129	29.92	29.97	— .09	63.6	+ 1.7	84	9	73	42	4	54	26	57	54	80	4.24	+ 0.7	10	8,120	sw.	39	n.	20	14	10	7	4.4	
Florida Peninsula.							70.8	+ 1.5									78	1.11	— 1.1										3.5	
Jupiter	28	10	46	29.94	29.97	— .08	70.3	+ 0.9	88	29	78	46	5	62	27	64	61	77	2.69	— 0.4	6	9,128	sw.	34	sw.	25	14	16	1	3.9	
Key West	22	10	83	29.94	29.96	— .09	74.6	+ 1.8	85	29	80	58	5	69	13	69	66	79	0.35	— 1.1	5	7,861	se.	36	w.	25	21	10	0	2.8	
Sand Key	25	41	71	29.92	29.95	— .10	73.6	.....	82	14	76	62	5	71	10	.....	.....	.....	0.15	— 1.3	1	11,138	se.	42	w.	25	17	14	0	3.3	
Tampa	35	79	96	29.95	29.98	— .09	67.6	+ 1.7	84	12	77	42	5	59	29	60	57	77	1.26	— 1.6	6	6,907	sw.	41	sw.	25	12	16	3	4.0	
East Gulf States.							58.6	+ 1.4									71	7.07	+ 1.2										5.3	
Atlanta	1,174	190	216	28.70	29.93	— .11	52.2	— 0.2	71	7	61	30	15	43	28	46	41	70	9.09	+ 3.3	14	8,788	nw.	66	nw.	24	10	11	10	5.4	
Macon	370	78	87	29.55	29.93	— .11	56.3	+ 1.5	79	9	67	35	16	46	30	.....	.....	.....	6.85	+ 1.4	14	5,724	nw.	36	w.	5	13	9	9	4.8	
Thomasville	273	8	57	29.67	29.97	— .09	61.4	+ 1.2	84	7	74	36	16	49	35	53	48	73	3.13	— 2.0	12	5,161	s.	26	sw.	21	12	11	8	4.4	
Pensacola	56	79	96	29.90	29.96	— .10	62.8	+ 1.7	79	21	70	40	16	56	22	.....	.....	.....	2.73	— 2.6	5	8,903	se.	40	s.	9	10	5	16	5.7	
Anniston	741	9	57	29.18	27.97	— .09	53.6	+ 1.1	76	27	64	29	16	43	33	.....	.....	.....	11.68	+ 5.9	14	5,668	n.	36	sw.	24	9	6	16	6.3	
Birmingham	700	11	48	29.20	29.97	— .09	55.0	— 0.2	75	8	64	31	15	46	29	49	44	72	9.34	+ 3.6	13	6,551	s.	36	s.	24	9	11	11	5.3	
Mobile	57	98	106	29.89	29.95	— .11	62.7	+ 3.6	79	21	71	38	16	54	26	56	52	76	2.39	— 4.8	7	7,526	se.	33	s.	9	10	10	11	5.2	
Montgomery	223	100	112	29.72	29.97	— .09	58.2	+ 0.3	80	8	68	34	15	48	29	51	45	67	16.51	+10.1	12	5,747	n.	32	sw.	24	12	7	12	5.4	
Meridian	375	84	93	29.55	29.95	— .10	57.4	+ 1.1	80	8	68	31	16	47	36	51	47	72	6.01	+ 0.4	11	5,322	n.	25	w.	9	11	9	11	5.3	
Vicksburg	247	62	74	29.68	29.96	— .08	59.8	+ 1.6	81	6	68	36	15	52	26	51	45	65	5.43	— 0.8	7	5,952	se.	28	s.	8	11	9	11	5.3	
New Orleans	51	90	121	29.88	29.94	— .10	65.2	+ 3.2	85	28	73	41	15	57	23	59	55	77	4.57	— 0.7	6	8,016	se.	37	se.	8	11	11	9	5.4	
West Gulf States.							58.8	+ 1.5									68	1.94	— 1.2										4.8	
Shreveport	249	77	84	26.67	29.94	— .08	58.8	+ 0.6	82	6	69	36	15	49	36	52	47	69	2.59	— 1.9	8	6,178	se.	42	se.	8	14	10	7	4.7	
Bentonville	960	11	44	28.55	29.93	— .08	47.9	+ 0.6	74	2	58	22	15	37	35	.....	.....	.....	3.13	— 0.7	9	5,379	n.	32	s.	24	10	9	12	5.3	T.
Fort Smith	457	168	94	29.45	29.93	— .08	51.8	+ 0.5	76	2	61	30	15	42	34	44	37	61	2.03	— 1.6	11	7,394	e.	42	sw.	24	13	8	10	4.9	
Little Rock	357	139	147	29.56	92.94	— .09	54.2	+ 1.5	78	2	63	32	15	45	34	46	38	62	3.70	— 1.2	10	7,644	e.	46	sw.	24	12	10	9	5.0	
Brownsville	57	4	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.15	.....	3	.....	s.	.....	.....	.....	.....	.....	.....	.....	.....	
Corpus Christi	20	69	77	29.88	29.90	— .08	66.8	+ 2.4	89	29	73	41	15	60	29	61	57	79	0.66	— 1.2	6	11,833	e.	40	e.	10	5	16	10	5.7	
Fort Worth	670	106	114	29.22	29.93	— .05	59.0	+ 2.4	91	26	71	34	10	47	41	.....	.....	.....	0 41	— 1.4	7	9,248	s.	52	w.	24	21	5	5	3.5	
Galveston	54	106	112	29.88	29.94	— .07	62.8	+ 0.5	82	28	68	43	15	58	20	59	56	84	1.97	— 0.9	9	8,189	se.	53	se.	8	11	15	5	4.9	
Palestine	510	73	79	29.39	29.92	— .08	60.0	+ 1.5	85	2	70	35	15	50	33	52	47	68	2.27	— 1.2	7	6,645	ne.	34	nw.	24	10	12	9	5.5	
San Antonio	701	80	191	29.17	29.89	— .09	65.5	+ 3.4	93	2	78	38	15	53	36	53	42	52	0.88	— 0.8	6	6,035	se.	30	nw.	8	13	12	6	4.6	
Taylor	583	55	63	29.32	29.93	— .06	61.7	+ 2.0	89	27	74	34	15	49	42	.....	.....	.....	1.74	— 0.9	6	7,872	s.	30	se.	23	15	9	7	4.4	
Ohio Val. and Tenn.							43.9	— 0.5									70	3.83	— 0.7										6.3	
Chattanooga	762	106	112	29.15	29.97	— .09	51.6	+ 0.3	71	8	60	32	26	43	32	41	38	65	6.74	+ 0.5	14	5,605	nw.	42	nw.	24	10	8	13	5.7	
Knoxville	996	93	100	28.88	29.93	— .11	48.1	— 0.1	76	9	57	28	18	39	32	42	36	69	5.98	+ 0.4	14	4,417	nw.	33	sw.	24	8	9	14	6.0	T.
Memphis	399	76	97	29.55	29.93	— .06	53.2	+ 1.1	77	8	61	34	15	46	30	46	39	64	2.93	— 2.8	14	7,083	n.	38	nw.	3	9	9	13	6.0	
Nashville	546	168	191	29.38	29.98	— .07	49.4	+ 0.2	70	8	59	31	26	40	35	44	40	75	4.94	— 0.5	11	6,052	nw.	40	s.	24	8	12	11	5.8	T.
Lexington	989	75	102	29.87	29.96	— .09	42.6	— 0.8	66	19	51	21	17	34	28	.....	.....	.....	3.97	— 0.8	14	9,532	nw.	44	nw.	25	6	7	18	6.8	T.
Louisville	525	111	132	29.38	29.97	— .08	45.2	— 0.1	68	19	54	23	17	37	28	39	32	65	5.08	+ 0.8	11	7,688	w.	38	nw.	3	9	4	18	6.5	T.
Evansville	431	72	82	29.48	29.95	— .09	45.0	+ 0.4	65	19	53	23	17	37	28	.....	.....	.....	3.58	— 1.0	10	6,313	nw.	41	s.	24	6	15	10	6.0	
Indianapolis	822	154	164	29.04	29.94	— .10	39.0	— 0.6	63	9	47	16	17	31	26	34	29	69	2.37	— 1.6	6	8,811	nw.	43	s.	9	6	9	16	6.8	T.
Cincinnati	628	152	160	39.26	29.95	— .10	42.2	— 0.6	62	19	50	19	17	34	28	36	29	63	2.44	— 1.2	12	6,787	nw.	34	w.	10	7	7	17	6.5	0.2
Columbus	824	173	222	29.04	29.94	— .10	38.1	— 1.1	58	9	46	16	17	30	28	34	29	72	2.68	— 0.5	12	11,296	nw.	50	nw.	4	7	7	17	6.8	0.9
Pittsburg	842	336	352	28.99	29.91	— .13	37.0	— 2.5	65	9	44	19	17	30	27	33	28	70	3.14	+ 0.1	17	9,759	nw.	48	w.	10	7	8	16	6.7	3.9
Parkersburg	638	77	84	29.28	29.94	— .11	41.6	— 0.7	64	9	50	22	18	33	34	37	33	78	2.27	— 1.6	14	6,210	nw.	25	nw.	25	8	10	13	6.3	T.
Elkins	1,940	41	50	27.83	29.94	— .11	37.4	— 1.7	78	9	47	15	18	28	34	33	29	79	3.28	— 0.8	20	4,034	w.	37	w.	25	8	6	17	6.5	11.3
Lower Lake Region.							51.6	— 0.7									78	2.65	0.0										6.6	
Buffalo	767	178	206	29.02	29.87	— .15	30.3	— 0.9	50	10	36	11	5	25	28	28	25	82	3.03	+ 0.4	17	11,689	w.	68	sw.	10	5	11	15	6.8	16.3
Canton	448	10	71	29.34	29.83	.....	25.0	— 2.7	45	27	33	1	21	17	24	.....	.....	.....	3.25	+ 0.4	17	9,093	w.	47	sw.	10	9	10	12	6.1	30.4
Oswego	335	76	91	29.46	29.84	— .17	30.2	— 1.2	52	10	36	14	5	25	22	28	26	82	2.56	— 0.3	10	9,911	nw.	41	nw.	11	5	6	20	6.9	7.7
Rochester	523	86	102	29.28	29.87	— .15	31.2	— 0.1	50	10	37	12	1	26	27	28	24	77	2.41	— 0.5	12	8,257	w.	38	w.	17	5	6	20	7.3	9.7
Syracuse	597	97	113	29.18	29.84	— .18	30.4	— 1.0	55	10	36	13	5	24	28	.....	.....	.....	3.80	+ 1.4	14	10,497	nw.	54	w.	11	5	6	20	7.4	29.2
Erie	714	92	102	29.10	29.89	— .13	32.0	— 1.1	63	9	38	17	5	26	35	29	25	78	2.54	— 0.1	15	8,905	w.	36	sw.	10	7	8	16	6.8	8.8
Cleveland	762	190	201	29.07	29.91	— .12	33.6	— 0.6	64	9	40	18	5	28	29	30	27	77	2.92	+ 0.1	14	12,136	w.	54	s.	9	4	15	12	6.3	10.3
Sandusky	229	62	70	29.21	29.90	— .13	35.2	0.0	64	9	41	21	18	29	32	.....	.....	.....	2.16	— 0.4	13	7,768	nw.	33	n.	3	9	7	15	6.1	1.6
Toledo	628	207	246	29.23	29.92	— .11	35.6	+ 0.8	62	9	43	20	17	28	31	31	27	74	2.13	— 0.2	11	12,417	w.	58	sw.	10	11	7	13	5.5	1.9
Detroit	780	218	258	29.10	29.91	— .12	32.9	0.0	53	9	40	15	17	26	27	29	25	75	1.71	— 0.7	11	11 324	nw.	50	w	10	6	11	14	6.5	5.0

TABLE I.—*Climatological data for U. S. Weather Bureau stations, March, 1909*—Continued.

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.									Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches.			Wind.				Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with .01, or more.	Total movement miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.					
Upper Lake Region.							**28.8**	**+ 1.5**										**79**	**1.45**	**— 0.8**									**6.4**	
Alpena	609	13	92	29.22	29.91	— .12	28.1	+ 3.1	48	31	36	6	18	20	27	25	22	81	1.78	— 0.3	14	8,692	nw.	37	e.	9	9	11	11	5.5	8.0
Escanaba	612	40	82	29.26	29.95	— .09	26.8	+ 3.3	45	31	35	3	5	19	27	24	21	82	1.70	— 0.2	14	6,920	nw.	34	nw.	25	6	10	15	6.8	17.0
Grand Haven	632	54	92	29.21	29.92	— .11	31.6	+ 0.8	46	23	37	16	18	26	20	29	26	81	1.29	— 1.2	14	8,711	nw.	40	nw.	10	7	8	16	6.6	5.5
Grand Rapids	707	127	162	29.14	29.93	— .10	32.1	— 0.9	50	1	38	16	17	26	23	29	25	77	1.37	— 1.2	11	8,485	nw.	36	nw.	10	5	7	19	7.2	2.8
Houghton	668	66	74	29.19	29.94	— .10	23.8	— 0.0	40	31	32	— 8	5	16	41	.....	.....	.....	1.23	— 0.9	17	4,832	e.	32	ne.	10	7	7	17	6.6	10.9
Marquette	734	77	116	29.13	29.96	— .08	26.2	+ 2.5	42	26	32	7	5	20	25	24	20	79	2.04	0.0	15	6,912	nw.	33	nw.	25	7	12	12	6.2	22.8
Port Huron	638	70	120	29.19	29.90	— .13	30.6	+ 1.0	47	31	37	12	5	25	22	28	24	78	1.54	— 0.9	12	9,113	nw.	37	nw.	4	7	8	16	6.7	3.9
Sault Sainte Marie	614	40	61	29.22	29.94	— .09	22.8	+ 1.5	41	23	32	— 8	5	14	35	21	17	81	1.53	— 0.3	9	6,209	nw.	33	w.	3	8	7	16	6.3	15.5
Chicago	823	140	310	29.03	29.94	— .09	36.0	+ 1.6	55	26	41	14	17	30	23	32	28	74	1.63	— 0.9	8	10,828	nw.	38	w.	16	6	8	17	6.7	3.8
Milwaukee	681	122	139	29.20	29.96	— .07	33.0	+ 2.1	50	1	38	8	17	28	19	30	27	80	0.86	— 1.8	10	8,018	w.	37	n.	3	10	12	9	5.5	2.0
Green Bay	617	49	86	29.94	29.92	— .12	29.4	+ 2.6	47	31	36	5	17	23	27	26	22	76	1.63	— 0.8	11	7,457	n.	46	ne.	9	6	7	18	6.9	12.3
Duluth	1,133	11	47	28.71	29.98	— .08	24.8	+ 0.7	43	31	32	— 5	17	18	27	22	19	82	0.78	— 0.8	9	9,179	nw.	49	nw.	24	11	9	11	5.3	6.7
North Dakota.							**24.8**	**+ 3.9**										**86**	**0.30**	**— 0.7**									**5.9**	
Moorhead	940	8	57	29.00	30.05	— .03	26.0	+ 4.6	46	23	33	— 1	17	19	32	24	23	93	0.42	— 0.7	9	7,080	nw.	30	nw.	26	12	8	11	5.3	3.4
Bismarck	1,674	8	57	28.23	30.08	+ .02	27.7	+ 5.6	60	25	36	6	14	19	38	24	22	83	0.27	— 0.8	8	8,988	nw.	42	nw.	2	7	9	15	6.6	3.6
Devils Lake	1,482	11	44	28.39	30.03	— .02	18.4	— 0.1	40	25	27	—10	17	10	40	17	16	91	0.39	— 0.6	10	9,303	nw.	44	n.	13	10	6	15	5.5	3.9
Williston	1,872	14	56	27.98	30.03	— .01	27.0	+ 5.4	55	25	35	2	14	19	35	23	19	76	0.12	— 0.6	3	7,498	nw.	44	w.	2	7	13	11	6.1	1.2
Upper Miss. Valley.							**35.9**	**— 0.1**										**74**	**1.90**	**— 0.5**									**6.2**	
Minneapolis	.....	102	208	.....	.....	.. ....	29.2	.....	50	23	36	2	17	23	22	.....	.....	...	0.40	— 1.2	5	9,422	w.	45	nw.	24	8	13	10	5.6	3.7
St. Paul	837	171	179	29.04	29.98	— .07	29.0	+ 0.8	49	23	35	2	17	23	24	26	21	72	0.49	— 1.1	8	8,703	nw.	38	nw.	16	7	19	5	5.0	4.4
La Crosse	714	11	48	29.17	29.96	— .08	30.0	— 0.9	49	23	38	— 1	17	22	25	.....	.....	...	1.36	— 0.3	6	4,237	nw.	24	nw.	16	6	10	15	6.5	15.2
Madison	974	70	78	28.88	29.96	— .08	30.4	+ 0.3	50	23	36	5	17	25	22	27	23	77	1.12	— 1.1	12	7,917	nw.	34	n.	3	6	12	13	6.4	4.2
Charles City	1,015	10	49	28.89	30.00	— .05	28.0	— 0.4	49	23	36	—12	17	20	33	26	24	85	2.11	+ 0.2	6	5,566	nw.	26	nw.	3	3	14	14	7.1	28.9
Davenport	606	71	79	29.29	29.97	— .06	35.8	+ 0.4	57	23	44	9	17	28	27	31	27	76	1.60	— 0.6	11	6,692	nw.	29	ne.	9	6	17	8	5.6	1.7
Des Moines	861	84	101	29.06	29.99	— .05	33.6	— 2.1	65	23	42	0	17	26	32	30	26	76	1.56	— 0.1	8	6,516	nw.	31	nw.	3	3	3	25	8.0	11.3
Dubuque	698	100	117	29.22	29.99	— .05	32.8	— 0.4	54	23	39	6	17	26	23	29	25	75	1.25	— 1.0	7	5,307	nw.	27	nw.	3	7	14	10	6.1	4.7
Keokuk	614	64	78	29.29	29.98	— .05	38.9	+ 1.0	62	2	47	11	17	30	30	33	28	71	1.84	— 0.5	8	6,393	nw.	32	nw.	13	9	17	5	4.9	0.3
Cairo	356	87	93	29.58	29.97	— .07	46.7	+ 0.6	67	26	55	28	15	40	30	42	36	66	7.10	+ 3.1	10	8,092	n.	40	sw.	24	7	8	16	6.5	T.
La Salle	536	56	64	29.37	29.96	— .07	36.2	— 0.6	59	26	44	12	17	28	30	.....	.....	.....	1.40	— 1.4	6	7,485	w.	30	sw.	9	6	15	10	6.1	3.7
Peoria	609	11	45	29.29	29.97	— .06	36.8	— 0.2	61	2	46	11	17	28	31	32	28	75	1.81	— 1.2	9	7,516	nw.	35	sw.	9	10	11	10	5.5	1.4
Springfield, Ill	644	10	91	29.25	29.95	— .08	40.2	+ 1.1	65	1	49	15	17	31	33	35	30	70	1.10	— 2.0	8	7,674	nw.	33	sw.	9	6	13	12	6.1	0.2
Hannibal	534	75	109	29.38	29.96	— .06	40.0	— 1.6	67	2	49	14	17	31	35	.....	.....	.....	1.65	— 1.1	5	7,692	nw.	40	sw.	9	2	16	13	6.5	T.
St. Louis	567	208	217	29.93	29.95	— .08	43.7	+ 0.2	73	26	52	19	17	35	38	38	32	68	3.69	+ 0.3	9	8,883	nw.	45	nw.	24	5	8	18	7.2	0.1
Missouri Valley.							**37.0**	**+ 0.9**										**72**	**1.23**	**— 0.7**									**5.2**	
Columbia, Mo	784	11	84	29.12	29.96	— .07	42.0	+ 0.6	72	18	53	17	15	31	37	.....	.....	.....	1.67	— 1.4	7	7,617	nw.	44	nw.	3	7	17	7	4.9	0.3
Kansas City	963	116	181	28.91	29.97	— .05	42.4	+ 1.6	77	23	51	21	17	34	35	36	30	66	1.50	— 1.3	5	9,877	nw.	42	nw.	9	9	16	6	5.0	1.0
Springfield, Mo	1,324	98	104	28.52	29.95	— .07	44.7	+ 1.2	73	23	54	20	15	35	32	39	34	72	1.53	— 2.5	4	8,667	nw.	36	nw.	24	16	7	8	4.3	T.
Iola	984	11	50	28.91	29.98	— .03	44.0	+ 1.6	75	18	55	23	15	33	38	.....	.....	.....	3.60	+ 1.2	5	6,644	ne.	34	sw.	23	11	7	13	5.5	1.9
Topeka	.....	85	101	.....	.....	.....	41.5	+ 0.6	80	23	52	20	14	31	36	.....	.....	.....	2.01	— 0.3	7	7,507	nw.	46	sw.	18	13	10	8	4.0	4.6
Lincoln	1,189	11	84	28.72	30.02	.00	36.5	+ 0.5	71	23	47	16	14	26	31	31	26	73	0.95	— 0.4	9	8,299	nw.	44	nw.	2	9	12	10	5.5	4.5
Omaha	1,105	115	121	28.80	30.02	— .02	35.8	— 0.2	65	23	44	16	17	28	23	31	26	72	0.63	— 0.8	6	7,790	nw.	37	n.	24	7	13	11	6.1	4.9
Valentine	2,598	47	54	27.25	30.05	+ .02	30.6	— 1.3	64	23	42	—10	9	20	44	27	22	75	1.14	— 0.1	3	7,078	nw.	37	nw.	2	10	17	4	4.3	10.6
Sioux City	1,135	96	164	28.79	30.04	— .01	31.8	— 0.8	65	23	39	11	17	24	27	28	24	75	0.74	— 0.5	6	2,700	nw.	48	nw.	13	5	17	9	6.1	8.0
Pierre	1,572	70	75	28.34	30.05	.00	33.8	+ 4.3	68	25	43	12	14	24	44	28	20	61	0.02	— 1.3	1	7,877	nw.	43	nw.	26	8	16	7	5.2	T.
Huron	1,306	56	67	28.63	30.07	+ .01	29.8	+ 3.1	61	23	37	9	17	22	30	26	23	80	0.21	— 0.8	8	8,973	nw.	42	nw.	13	10	7	14	5.4	1.8
Yankton	1,233	49	57	28.67	30.03	— .02	30.9	— 0.3	61	23	39	10	9	23	31	.....	.....	.....	0.75	— 0.4	4	6,633	w.	33	w.	13	8	14	9	5.7	10.3
Northern Slope.							**32.4**	**+ 1.0**										**69**	**1.02**	**— 0.1**									**5.0**	
Havre	2,505	11	44	27.31	30.01	+ .01	31.4	+ 4.1	63	31	42	— 8	11	20	42	27	23	77	0.24	— 0.2	4	5,775	e.	35	ne.	25	17	15	3	4.3	2.5
Miles City	2,371	26	48	27.46	30.08	+ .06	34.0	+ 5.4	63	4	46	6	11	22	40	29	24	73	0.29	— 0.5	5	4,536	se.	34	n.	28	14	8	9	4.7	1.8
Helena	4,110	8	56	25.74	30.02	+ .01	33.2	+ 2.2	57	31	43	— 4	11	24	29	28	22	64	0.55	— 0.2	9	4,233	sw.	35	w.	4	11	7	13	5.6	8.2
Kalispell	2,962	11	34	26.87	29.97	— .02	34.6	+ 1.6	58	25	44	7	11	26	29	30	24	69	0.72	— 0.4	7	3,437	nw.	20	w.	1	12	10	9	4.9	3.7
Rapid City	3,234	46	50	26.54	30.05	+ .04	33.4	+ 1.8	63	25	44	6	12	22	38	27	20	62	0.09	— 1.0	3	6,029	n.	34	nw.	25	13	13	5	4.3	2.3
Cheyenne	6,088	56	64	23.88	29.98	+ .02	30.5	— 2.5	53	22	40	— 8	12	21	38	27	22	73	3.22	+ 2.3	14	7,563	nw.	50	w.	1	10	14	7	4.8	35.9
Lander	5,372	26	36	24.55	30.00	+ .01	30.6	— 0.7	57	4	42	—15	12	19	40	26	20	65	2.34	+ 0.7	10	2,348	ne.	28	w.	1	10	10	11	5.6	18.4
Sheridan	3,790	9	47	26.03	30.01	.....	32.2	.....	63	25	45	— 5	11	20	39	27	20	65	0.29	.....	7	4,904	nw.	48	nw.	10	10	13	8	4.8	7.1
Yellowstone Park	6,200	11	48	23.76	30.01	— .01	28.0	+ 1.5	48	16	38	—13	11	18	35	24	19	72	0.77	— 1.4	12	5,674	sw.	30	sw.	25	5	13	13	6.2	11.6
North Platte	2,821	11	51	27.04	30.04	+ .04	36.0	+ 0.7	66	18	48	12	8	24	43	30	25	73	0.98	+ 0.1	6	5,980	n.	39	ne.	24	13	9	9	4.5	6.1
Middle Slope.							**41.6**	**— 0.9**										**65**	**1.64**	**+ 0.2**									**5.4**	
Denver	5,291	129	136	24.62	29.96	+ .01	37.0	— 1.7	65	4	48	5	8	27	32	31	23	63	3.03	+ 2.0	10	5,490	sw.	36	w.	2	12	11	8	5.0	20.2
Leadville	10,242	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pueblo	4,685	80	86	25.18	29.91	— .01	39.6	— 1.0	71	4	53	— 6	12	26	39	32	22	58	0.79	— 0.1	8	6,191	se.	50	w.	26	13	12	6	4.5	3.0
Concordia	1,398	42	50	28.51	30.01	.00	39.9	— 0.8	76	23	51	14	13	29	41	34	29	72	1.24	— 0.2	6	5,285	nw.	36	n.	24	9	14	8	5.5	6.2
Dodge City	2,509	44	54	27.34	29.99	+ .02	40.7	— 1.0	73	2	54	7	13	28	43	33	26	65	1.15	+ 0.3	6	6,907	nw.	37	n.	24	12	12	7	4.8	7.9
Wichita	1,358	98	121	28.54	29.99	.00	43.2	— 0.9	75	18	54	19	13	33	36	37	30	65	1.47	— 0.8	7	8,795	n.	47	n.	24	11	12	8	5.0	13.0
Oklahoma	1,214	10	47	28.64	29.94	— .04	49.2	0.0	83	5	61	25	10	38	38	41	34	65	2.13	— 0.2	10	12,089	n.	56	nw.	24	6	16	9	5.8	1.6
Southern Slope.							**54.0**	**+ 0.8**										**53**	**4.82**	**— 0.2**									**4.4**	
Abilene	1,738	45	54	28.10	29.91	— .05	57.6	+ 2.7	87	5	71	29	12	44	42	44	29	44	0.39	— 1.0	2	7,631	nw.	48	w.	24	10	13	8	5.2	
Amarillo	3,676	10	49	26.16	29.91	— .04	44.9	— 0.1	80	22	58	14	12	31	45	36	29	63	1.28	+ 0.6	5	9,545	nw.	60	nw.	24	21	8	2	3.6	12.5
Del Rio	944	8	57	28.91	29.89	— .06	66.0	+ 4.3	94	27	80	33	15	52	41	.....	.....	.....	2.18	+ 0.5	4	6,958	se.	36	nw.	8	12	16	3	4.1	
Roswell	3,578	9	57	26.27	29.92	+ .02	47.4	— 3.9	82	5	64	— 2	13	31	54	37	25	51	0.97	+ 0.5	4	6,481	n.	36	nw.	29	12	12	7	4.6	7.9
Southern Plateau.							**47.0**	**— 4.0**										**49**	**0.74**	**— 0.2**									**3.6**	
El Paso	3,762	110	133	26.10	29.87	— .01	52.4	— 3.5	76	4	65	23	13	40	36	39	21	35	0.77	+ 0.4	4	10,570	w.	60	w.	23	16	12	3	3.7	0.6
Santa Fe	7,013	8	56	23.13	29.91	+ .02	36.6	— 2.8	59	22	48	12	12	26	31	28	18	52	0.73	0.0	8	7,068	ne.	44	e.	10	10	18	3	4.2	7.7
Flagstaff	6,907	8	57	25.22	29.86	— .05	32.3	— 3.6	54	31	44	2	24	21	43	28	21	66	1.46	— 0.4	10	6,199	sw.	34	sw.	6	11	11	9	5.0	15.1
Phoenix	1,108	50	56	28.75	29.92	+ .01	56.8	— 3.7	82	16	70	34	12	44	33	46	33	48	0.67	+ 0.2	6	3,442	e.	22	sw.	23	15	13	3	3.6	
Yuma	141	9	58	29.77	29.92	— .02	59.6	— 4.9	83	2	74	35	13	45	40	47	33	44	0.64	+ 0.3	2	5,545	w.	37	nw.	18	28	3	0	1.2	
Brawley	†105	11	31	30.05	29.94	.....	60.0	.....	82	31	74	35	12	46	41	48	36	46	0.56	.....	5	5,884	nw.	34	nw.	7	18	9	4	3.1	
Independence	3,910	11	42	25.90	29.91	— .03	44.2	— 5.4	68	31	57	22	19	31	36	37	25	50	0.16	— 1.6	3	7,083	s.	48	n.	9	18	10	3	3.6	T.
Middle Plateau.							**38.7**	**— 1.0**										**59**	**0.97**	**— 0.4**									**4.9**	
Reno	4,532	56	63	25.39	29.97	— .01	39.4	— 1.6	65	2	51	19	10	28	40	32	22	54	0.27	— 1.0	6	4,689	w.	27	sw.	29	10	15	6	4.5	3.1
Tonopah	6,090	12	20	23.95	30.00	.....	35.8	+ 0.4	57	31	45	16	10	27	28	30	20	56	0.34	— 1.0	6	8,725	se.	37	nw.	7	10	17	4	4.8	2.3
Winnemucca	4,344	18	56	25.54	29.97	— .04	39.4	— 0.2	65	16	52	18	10	27	39	33	27	67	0.84	— 0.1	11	5,133	sw.	41	nw.	9	9	9	13	5.3	3.7
Modena	5,479	10	43	24.51	29.90	— .06	36.4	— 2.8	59	2	48	12	12	25	35	32	28	73	0.95	— 0.4	8	7,798	w.	45	sw.	6	9	13	9	5.2	10.2
Salt Lake City	4,360	105	110	25.52	29.92	— .06	41.2	— 0.2	60	16	49	19	12	33	26	35	27	58	2.85	+ 0.8	12	4,744	se.	30	se.	23	9	11	11	5.3	11.0
Durango	6,546	18	56	23.53	29.91	— .01	35.2	— 2.3	57	22	47	6	12	23	35	28	21	61	1.27	— 0.2	7	4,256	nw.	34	w.	23	10	16	5	4.7	9.8
Grand Junction	4,608	43	51	25.27	29.86	— .08	43.4	— 0.1	64	22	55	21	12	32	35	34	22	47	0.02	— 0.8	2	3,767	se.	27	w.	23	14	9	8	4.4	T.
Northern Plateau.							**43.2**	**+ 3.0**										**64**	**1.01**	**— 0.6**									**5.8**	
Baker City	3,471	48	58	26.38	29.99	— .04	40.6	+ 5.1	62	16	51	21	30	30	32	36	30	68	0.86	— 0.6	5	4,757	s.	28	nw.	9	8	10	13	5.7	7.8
Boise	2,739	79	86	27.12	30.00	— .03	43.8	+ 1.6	65	16	53	24	11	34	32	37	27	55	0.64	— 0.8	10	4,507	nw.	29	nw.	17	10	6	15	6.2	T.
Lewiston	757	10	51	29.20	30.02	— 0.1	46.8	+ 2.8	70	25	58	28	18	36	37	.....	.....	.....	1.02	— 0.3	7	3,742	e.	45	nw.	4	7	10	14	6.2	
Pocatello	4,477	46	84	25.39	29.97	— .04	37.8	+ 0.9	56	26	46	11	11	30	25	33	27	68	1.41	— 0.3	10	6,458	se.	30	sw.	28	9	9	13	5.9	2.6
Spokane	1,929	101	110	27.92	29.99	— .02	42.2	+ 3.3	63	24	53	24	7	32	34	36	28	60	0.12	— 1.4	5	4,773	s.	40	sw.	1	5	9	17	6.7	0.1
Walla Walla	1,000	71	79	28.92	30.00	— .02	48.0	+ 4.0	67	25	58	29	11	38	31	42	37	69	2.02	+ 0.1	9	4,717	s.	34	sw.	3	15	13	3	4.3	0.8
N. Pac. Coast Reg.							**44.2**	**0.0**										**80**	**2.72**	**— 2.2**									**6.5**	
Blaine	58	4	.....	.....	.....	.....	.....	.....	56	28	...	28	6	.....	.....	.....	.....	.....	2.93	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
North Head	211	11	56	29.78	30.02	+ .01	44.1	— 0.8	59	15	48	35	5	41	18	43	41	87	3.50	— 1.8	19	13,347	nw.	68	se.	30	7	10	14	6.4	
port Crescent	259	8	53	29.74	30.02	+ .04	39.9	— 0.6	54	15	47	29	22	32	25	.....	.....	.....	2.49	— 1.4	15	4,002	ne.	19	ne.	20	6	13	12	6.1	T.

TABLE I.—*Climatological data for U. S. Weather Bureau stations, March, 1909*—Continued.

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.								Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.				
N. P. Coast Reg—Cont.																													
Seattle	123	185	224	29.91	30.04	+ .05	44.1	— 0.1	58	24	50	33	11	38	22	41	38	82	1.08	— 2.5	14	6,342	n.	41	sw.	1	3	11	17	7.6	
Tacoma	213	113	120	29.79	30.02	+ .02	44.1	— 0.1	60	24	52	30	10	37	26	42	38	82	2.12	— 1.9	14	4,233	sw.	34	sw.	1	9	10	12	5.9	T.
Tatoosh Island	86	7	57	29.89	29.99	+ .03	43.6	+ 0.7	51	22	47	35	17	40	12	41	39	84	3.90	— 2.7	17	10,717	e.	54	ne.	6	6	10	15	6.7	0.8
Portland, Oreg.	153	68	106	29.87	30.03	+ .01	47.6	+ 1.3	70	15	55	34	7	40	31	43	38	71	2.35	— 2.8	14	4,579	nw.	32	sw.	1	11	4	16	6.0	
Roseburg	510	9	57	29.48	30.04	.00	46.1	— 0.5	68	25	56	29	11	36	37	42	37	75	1.62	— 2.4	13	2,399	nw.	34	sw.	3	3	15	13	6.5	
Mid. Pac. Coast Reg.							50.5	— 2.0										78	3.08	— 0.7									9.3	
Eureka	62	62	80	30.00	30.07	+ .01	47.4	— 0.6	61	31	53	36	10	42	19	44	40	79	2.72	— 4.2	12	5,825	se.	44	n.	9	7	12	12	5.8	
Mount Tamalpais	2,375	11	18	27.53	30.03	— .03	43.1	.....	59	2	49	32	21	38	21	40	39	89	3.57	+ 0.3	12	13,570	nw.	75	nw.	8	12	7	12	5.4	1.4
Point Reyes Light	490	7	18	29.47	29.99	.....	48.7	.....	63	2	53	38	21	44	16	.....	.....	.....	2.86	.....	11	14,746	nw.	79	nw.	8	10	10	11	5.9	
Red Bluff	332	50	56	29.65	30.01	— .03	51.5	— 2.3	69	15	60	32	21	43	28	45	38	66	4.46	+ 0.7	11	5,037	se.	32	n.	9	15	7	9	4.5	3.0
Sacramento	69	106	117	29.93	30.02	— .01	51.4	— 2.8	66	31	58	37	20	44	23	46	40	68	1.84	— 1.2	11	7,189	s.	39	s.	21	14	5	12	5.1	
San Francisco	155	200	204	29.87	30.04	— .02	51.8	— 0.9	67	12	57	41	29	46	21	46	41	71	3.27	+ 0.1	13	5,532	w.	34	se.	20	11	9	11	5.5	
San Jose	141	12	110	29.89	30.04	.....	50.4	— 3.3	70	2	60	34	5	41	31	.....	.....	.....	2.77	— 0.2	13	4,869	nw.	35	se.	20	14	11	6	4.3	
Southeast Farallon	90	9	17	30.01	30.04	.....	50.2	.....	60	2	53	42	21	48	12	.....	.....	.....	2.94	— 0.2	13	10,922	nw.	60	n.	9	11	9	11	5.6	
S. Pac. Coast Reg.							53.0	— 2.1										72	2.59	0.0									4.6	
Fresno	330	67	70	29.66	30.02	+ .01	52.1	— 2.8	72	2	63	35	5	41	32	46	40	69	1.18	— 0.6	7	4,287	nw.	24	e.	21	16	7	8	4.2	
Los Angeles	338	159	191	29.64	30.00	— .02	55.0	— 0.6	76	2	63	43	8	47	25	48	42	69	2.51	— 0.5	7	5,373	ne.	34	nw.	7	10	13	8	5.1	
San Diego	87	94	102	29.92	30.01	— .01	54.5	— 1.7	74	31	61	42	12	48	26	49	45	75	2.62	+ 0.9	11	5,026	nw.	38	sw.	21	16	8	7	4.1	
San Luis Obispo	201	47	54	29.83	30.05	— .01	50.6	— 3.2	72	2	60	33	12	42	34	46	42	74	4.04	+ 0.1	12	4,173	n.	22	ne.	8	10	12	9	5.1	
West Indies.																															
Grand Turk	11	6	20	29.99	29.98	— .04	77.0	.....	86	21	83	66	18	71	.....	.....	.....	.....	0.28	.....	6	.....	ne.	.....	.....	.....	.....	.....	.....	.....	
San Juan	82	48	90	29.88	29.97	— .05	76.8	.....	89	27	83	68	19	71	16	72	70	83	2.53	+ 0.2	10	7,747	se.	31	se.	26	20	8	3	3.2	
Panama.																															
Christobal	17	5	60	29.83	29.84	.....	79.3	.....	84	31	82	70	28	76	13	75	73	81	1.85	.....	19	10,134	n.	28	n.	18	11	15	5	5.0	
Bas Obispo	172	4	30	29.66	29.84	.....	78.4	.....	91	29	87	65	28	70	22	73	72	90	0.45	.....	5	3,985	nw.	21	nw.	2	4	24	3	6.0	
Ancon	92	6	69	29.73	29.82	.....	81.4	.....	93	17	90	70	4	72	22	74	72	84	0.18	.....	1	7,664	nw.	24	nw.	8	2	25	4	6.0	
Alhajuela	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.29	.....	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Bohio	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.66	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Gatun	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.99	.....	19	.....	.....	.....	.....	.....	.....	.....	.....	.....	

† Below sea level.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for storms in which the rate of fall equaled or exceeded 0.25 in any 5 minutes, or 0.80 inch in 1 hour, during March, 1909, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated. 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex. †	8	.....	.....	0.33	.....	.....	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	0.33	.....	.....	.....
Albany, N. Y	25	.....	.....	0.89‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Alpena, Mich	9–10	.....	.....	0.94	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Amarillo, Tex	30–31	.....	.....	0.57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Anniston, Ala	9	12:38 p. m.	8:00 p. m.	2.68	1:32 p. m.	2:11 p. m.	0.08	0.11	0.24	0.75	0.98	1.04	1.05	1.15	1.21	.....	.....	.....	.....	.....	.....
Do	12–13	9:15 a. m.	3:00 p. m.	3.24	9:04 a. m.	10:05 a. m.	0.70	0.13	0.23	0.40	0.52	0.61	0.66	0.73	0.82	0.88	0.95	1.21	.....	.....	.....
Asheville, N. C	28	.....	.....	0.66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.39	.....	.....	.....
Atlanta, Ga	9	3:38 p. m.	10:05 p. m.	2.29	5:14 p. m.	5:54 p. m.	0.05	0.21	0.54	0.84	0.96	1.02	1.14	1.27	1.34	.....	.....	.....	.....	.....	.....
Atlantic City, N. J	25	.....	.....	1.07	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.27	.....	.....	.....
Augusta, Ga	10	12:05 a. m.	4:30 a. m.	0.82	12:37 a. m.	1:03 a. m.	0.12	0.08	0.11	0.20	0.23	0.45	.....	.....	.....	.....	.....	.....	.....	.....	.....
Baker City, Oreg	4	.....	.....	0.31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Baltimore, Md	3–4	.....	.....	2.33‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Bentonville, Ark	5	.....	.....	0.62	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.61	.....	.....	.....
Binghamton, N. Y	4	.....	.....	0.93‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.18	.....	.....	.....
Birmingham, Ala	20	.....	.....	1.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.69	.....	.....	.....
Bismarck, N. Dak	14–15	.....	.....	0.11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Block Island, R. I	25	.....	.....	1.16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.29	.....	.....	.....
Boise, Idaho	19–20	.....	.....	0.27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.13	.....	.....	.....
Boston, Mass	10	.....	.....	0.39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.29	.....	.....	.....
Buffalo, N. Y	27	.....	.....	0.28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.20‡	.....	.....	.....
Burlington, Vt	4–5	.....	.....	0.46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Cairo, Ill	5–6	8:26 p. m.	D. N.	2.31	8:37 p. m.	10:17 p. m.	0.01	0.08	0.35	0.63	0.84	1.05	1.23	1.34	1.40	1.41	1.43	1.54	1.92	2.07	.....
Canton, N. Y	25–26	.....	.....	1.26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Charles City, Iowa	9	.....	.....	1.42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Charleston, S. C	28	1:23 p. m.	3:10 p. m.	0.78	1:46 p. m.	2:06 p. m.	0.08	0.11	0.35	0.48	0.53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Charlotte, N. C	25	.....	.....	0.58	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.43	.....	.....	.....
Chattanooga, Tenn	9	10:53 a. m.	7:55 p. m.	2.18	1:58 p. m.	2:49 p. m.	0.56	0.07	0.13	0.18	0.27	0.31	0.33	0.36	0.40	0.83	0.96	1.01	.....	.....	.....
Cheyenne, Wyo	23–24	.....	.....	0.97	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Chicago, Ill	8	.....	.....	0.43	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Cincinnati, Ohio	8	.....	.....	0.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.33	.....	.....	.....
Cleveland, Ohio	9	.....	.....	0.92	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.24	.....	.....	.....
Columbia, Mo	8	.....	.....	0.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.30	.....	.....	.....
Columbia, S. C	9–10	11:30 p. m.	8:08 a. m.	0.80	2:07 a. m.	2:15 a. m.	0.40	0.32	0.37	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Columbus, Ohio	24	.....	.....	0.65	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.30	.....	.....	.....
Concord, N. H	25–26	.....	.....	1.46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Concordia, Kans	24	.....	.....	0.38‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.17	.....	.....	.....
Corpus Christi, Tex	31	10:28 p. m.	11:35 p. m.	0.34	10:31 p. m.	10:38 p. m.	0.01	0.27	0.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Davenport, Iowa	8–9	.....	.....	1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Del Rio, Tex	11	10:50 p. m.	11:40 p. m.	1.45	11:00 p. m.	11:33 p. m.	0.01	0.21	0.47	0.66	0.81	1.15	1.39	1.44	.....	.....	.....	.....	.....	.....	.....
Denver, Colo	23–24	.....	.....	2.43	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Des Moines, Iowa	8–9	.....	.....	1.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Detroit, Mich	24	.....	.....	0.74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.24	.....	.....	.....
Devils Lake, N. Dak	12	.....	.....	0.14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Dodge City, Kans	19	.....	.....	0.44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Dubuque, Iowa	8–9	.....	.....	0.48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Duluth, Minn	2	.....	.....	0.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Durango, Colo	9–10	.....	.....	0.56	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Eastport, Me	28	.....	.....	1.91	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.24	.....	.....	.....
Elkins, W. Va	3	.....	.....	0.54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.16	.....	.....	.....
El Paso, Tex	10	.....	.....	0.28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.14	.....	.....	.....
Erie, Pa	24–25	.....	.....	0.92	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Escanaba, Mich	9–10	.....	.....	0.88‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Eureka, Cal	3	.....	.....	0.43	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.20	.....	.....	.....
Evansville, Ind	24	6:35 p. m.	8:00 p. m.	0.37	6:38 p. m.	6:43 p. m.	T.	0.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, etc.*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated. 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Flagstaff Ariz	23			0.50														*			
Fort Smith, Ark	8			0.86														0.28			
Fort Worth, Tex	8			0.24														0.20			
Fresno, Cal	29			0.35														0.27			
Galveston, Tex	12	6:20 a. m.	8:50 a. m.	0.95	6:39 a. m.	7:22 a. m.	0.07	0.10	0.12	0.17	0.25	0.30	0.39	0.46	0.68	0.74					
Grand Haven, Mich	26			0.41														*			
Grand Junction, Colo	29–30			0.02														*			
Grand Rapids, Mich	26			0.35‡														0.13			
Green Bay, Wis	9			0.79														*			
Greenville, Me	17			1.40														*			
Hannibal, Mo	7			0.18														0.16			
Harrisburg, Pa	3			0.68														0.13			
Hartford, Conn	25			1.62														0.27			
Hatteras, N. C	2			0.56														0.28			
Havre, Mont	9–10			0.18														*			
Helena, Mont	12			0.21														*			
Houghton, Mich	23			0.25														*			
Huron, S. Dak	15			0.10														*			
Independence, Cal	25			0.12														0.06			
Indianapolis, Ind	8–9			1.75														*			
Iola, Kans	8	7:08 a. m.	7:40 a. m.	0.51	7:11 a. m.	7:26 a. m.	0.01	0.15	0.39	0.50											
Jacksonville, Fla	24–25	10:55 p. m.	D. N.	2.29	1:28 a. m.	3:06 a. m.	0.39	0.06	0.17	0.23	0.28	0.35	0.42	0.49	0.56	0.60	0.65	0.77	1.47	1.81	
Jupiter, Fla	2	11:50 a. m.	1:35 p. m.	1.09	12:30 p. m.	1:31 p. m.	0.10	0.07	0.16	0.37	0.42	0.47	0.48	0.55	0.59	0.66	0.80	0.94	0.99		
Do	15	2:50 p. m.	5:40 p. m.	0.80	3:09 p. m.	3:24 p. m.	0.03	0.21	0.44	0.50											
Kalispell, Mont	8–9			0.39														*			
Kansas City, Mo	8			0.76														0.22			
Keokuk, Iowa	7–8			0.80														*			
Key West, Fla	2			0.09														0.09			
Knoxville, Tenn	9			1.24														0.54			
La Crosse, Wis	9			1.01†														*			
Lander, Wyo	9			0.79														*			
La Salle, Ill	9			0.70														0.09			
Lewiston, Idaho	4			0.33‡														0.21			
Lexington, Ky	9			1.13														0.47			
Lincoln, Nebr	31			0.24														*			
Little Rock, Ark	8			1.79														0.60			
Los Angeles, Cal	21			1.11														0.26			
Louisville, Ky	9			2.68														0.71			
Lynchburg, Va	3			0.25														0.23			
Macon, Ga	9–10	7:40 p. m.	D. N.	0.96	10:03 p. m.	10:12 p. m.	0.16	0.37	0.45												
Do	13–14	6:30 p. m.	6:30 a. m.	1.00	6:12 p. m.	7:00 p. m.	0.01	0.14	0.23	0.36	0.40							*			
Madison, Wis	8–9			0.64														*			
Marquette, Mich	9–10			0.90																	
Memphis, Tenn	8–9	7:30 p. m.	8:40 a. m.	0.87	2:29 a. m.	2:40 a. m.	0.10	0.21	0.35	0.38											
Meridian, Miss	9	7:20 a. m.	10:15 a. m.	0.68	7:33 a. m.	7:43 a. m.	0.02	0.15	0.33												
Do	13	3:45 p. m.	8:30 p. m.	0.61	6:09 p. m.	6:24 p. m.	0.18	0.13	0.26	0.39								0.07			
Milwaukee, Wis	26			0.12														*			
Minneapolis, Minn	9			0.16																	
Mobile, Ala	9	3:50 p. m.	6:33 p. m.	0.76	4:10 p. m.	4:29 p. m.	0.04	0.10	0.28	0.38	0.45										
Do	13–14	D. N.	D. N.	0.69	11:41 p. m.	11:58 p. m.	0.07	0.10	0.24	0.45	0.54							*			
Modena, Utah	22			0.40																	
Montgomery, Ala	9			5.53	2:05 p. m.	2:55 p. m.	0.05	0.06	0.15	0.40	0.62	0.87	1.01	1.02	1.04	1.15	1.27				
					2:55 p. m.	3:45 p. m.		1.38	1.62	1.64	1.67	1.79	1.84	1.91	1.96	2.00	2.08				
					3:45 p. m.	4:35 p. m.		2.17	2.26	2.31	2.35	2.41	2.45	2.54	2.83	2.98	3.08				
					4:35 p. m.	5:25 p. m.		3.36	3.63	3.74	3.82	3.98	4.16	4.35	4.54	4.60	4.65				
					5:25 p. m.	6:04 p. m.		4.66	4.67	4.73	4.88	4.96	5.01	5.06	5.09						
Do	11–12	2:34 p. m.	10:22 a. m.	5.42	8:15 p. m.	9:37 p. m.	2.55	0.10	0.22	0.27	0.33	0.42	0.45	0.46	0.58	0.76	0.91	0.99	1.59	1.61	
Moorhead, Minn	28–29			0.14														*			
Mount Tamalpais, Cal	6			1.34														0.25			
Mount Weather, Va	3			0.66‡														0.13			
Nantucket, Mass	25			1.19														0.20			
Nashville, Tenn	19			1.39														0.44			
New Haven, Conn	25			2.09														0.42			
New Orleans, La	13–14	8:20 p. m.	9:05 a. m.	2.08	3:18 a. m.	3:47 a. m.	0.78	0.05	0.17	0.40	0.56	0.61	0.69								
Do	24	12:25 p. m.	7:15 p. m.	0.82	1:00 p. m.	1:14 p. m.	T.	0.25	0.49	0.55											
New York, N. Y	25			1.63														0.40			
Norfolk, Va	25			0.24														0.21			
Northfield, Vt	25–26			0.89														*			
North Head, Wash	31			0.58														0.14			
North Platte, Nebr	23–24			0.67														*			
Oklahoma, Okla	8	D. N.	6:25 a. m.	0.87	5:38 a. m.	6:03 a. m.	0.19	0.08	0.22	0.48	0.55	0.66									
Omaha, Nebr	9			0.22														*			
Oswego, N. Y	24–25			1.46														*			
Palestine, Tex	13			1.12														*			
Parkersburg, W. Va	3			0.26														0.19			
Pensacola, Fla	9	5:35 p. m.	9:30 p. m.	1.08	6:29 p. m.	6:50 p. m.	0.10	0.26	0.32	0.45	0.59	0.62									
Peoria, Ill	24			0.67														*			
Philadelphia, Pa	25			0.78														*			
Phoenix, Ariz	23			0.36														0.17			
Pierre, S. Dak	26			0.02														*			
Pittsburg, Pa	9			0.62														*			
Pocatello, Idaho	6			0.28														*			
Point Reyes Light, Cal	5–6																	0.23			
Port Huron, Mich	24			0.63														0.09			
Portland, Me	25			1.02														0.21			
Portland, Oreg	31			0.25														0.24			
Providence, R. I	25			1.56														0.26			
Pueblo, Colo	28–29			0.27														*			
Raleigh, N. C	3	11:41 a. m.	1:25 p. m.	0.73	12:22 p. m.	1:02 p. m.	0.03	0.10	0.22	0.30	0.36	0.43	0.51	0.57	0.63						
Do	24–25	9:40 p. m.	6:10 a. m.	0.60	5:02 a. m.	5:11 a. m.	0.16	0.22	0.34									*			
Rapid City, S. Dak	10–11			0.08																	
Red Bluff, Cal	6	2:30 p. m.	9:00 p. m.	1.85	4:24 p. m.	5:00 p. m.	0.23	0.06	0.22	0.33	0.40	0.48	0.63	0.75	0.79						
Do	19	3:31 p. m.	4:45 p. m.	0.50	3:51 p. m.	4:06 p. m.	0.04	0.12	0.33	0.37								*			
Reno, Nev	21–22			0.13														0.46			
Richmond, Va	3			1.90														0.15			
Rochester, N. Y	25			1.13														0.13			
Roseburg, Oreg	3			0.19														0.12			
Roswell, N. Mex	31			0.18														0.20			
Sacramento, Cal	20			0.49														0.38			
St. Louis, Mo	8			2.27														*			
St. Paul, Minn	9			0.24														*			
Salt Lake City, Utah	6–7			0.76																	
San Antonio, Tex	12	7:15 a. m.	11:00 a. m.	0.53	9:14 a. m.	9:30 a. m.	0.08	0.14	8.28	0.42	0.43							0.47			
San Diego, Cal	21			0.65																	

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, etc.*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Sand Key, Fla.	22			0.15														0.14			
Sandusky, Ohio	9			0.87														*			
San Francisco, Cal	20			1.02														0.38			
San Jose, Cal	6			0.59														0.21			
San Luis Obispo, Cal.	21			1.14														0.42			
Santa Fe, N. Mex	18–19			0.30														*			
Sault Sainte Marie, Mich	9–10			0.44														*			
Savannah, Ga	2			0.54														0.40			
Scranton, Pa	25			1.14‡														0.20			
Seattle, Wash	3			0.26														0.08			
Sheridan, Wyo	12			0.12														*			
Shreveport, La	13			1.62														0.50			
Sioux City, Iowa	7–8			0.39														*			
Southeast Farallon, Cal.	5–6																	0.31			
Spokane, Wash	30			0.02														0.02			
Springfield, Ill	24			0.36														0.09			
Springfield, Mo	8			0.95														*			
Syracuse, N. Y	25–26			1.30														*			
Tacoma, Wash	8			0.54														0.24			
Tampa, Fla	2	7:15 a. m.	8:15 a. m.	0.38	7:30 a. m.	8:00 a. m.	0.02	0.21	0.35												
Tatoosh Island, Wash	17			0.40														0.21			
Taylor, Tex	19	2:44 p. m.	4:23 p. m.	0.57	2:55 p. m.	3:05 p. m.	0.01	0.29	0.41												
Thomasville, Ga	24			0.83														0.56			
Toledo, Ohio	9			0.66														0.27			
Tonopah, Nev	21			0.16														*			
Topeka, Kans	23–24			0.91†														0.35			
Valentine, Nebr.	7			1.02														*			
Vicksburg, Miss.	19	4:00 p. m.	6:40 p. m.	1.62	5:43 p. m.	6:03 p. m.	0.27	0.18	0.80	1.20	1.33										
Walla Walla, Wash	4			0.45														0.20			
Washington, D. C	3			1.75														0.40			
Wichita, Kans.	9			0.98														*			
Williston, N. Dak	14–15			0.11														*			
Wilmington, N. C.	10			0.23														0.22			
Winnemucca, Nev.	21			0.33														*			
Wytheville, Va.	3			0.44‡														0.31			
Yankton, S. Dak	7			0.67														*			
Yellowstone Park, Wyo.	1			0.29														*			

• Self register not working. † Partly estimated ‡ Estimated.

TABLE III.—*Data furnished by the Canadian Meteorological Service, March, 1909.*

Stations.	Pressure.			Temperature.				Precipitation.			Stations.	Pressure.			Temperature.				Precipitation.		
	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean.	Departure from normal.	Mean maximum.	Mean minimum.	Total.	Departure from normal.	Total snowfall.		Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean.	Departure from normal.	Mean maximum.	Mean minimum.	Total.	Departure from normal.	Total snowfall.
	Ins.	*Ins.*	*Ins.*	°	°	°	°	*Ins.*	*Ins.*	*Ins.*		*Ins.*	*Ins.*	*Ins.*	°	°	°	°	*Ins.*	*Ins.*	*Ins.*
St. Johns, N. F	29.44	29.58	—.30	30.9	+ 3.2	35.5	26.3	5.84	+1.08	17.0	Parry Sound, Ont	29.16	29.89	—.13	24.2	+ 3.1	33.2	15.2	2.68	+0.45	22.0
Sydney, C. B. I	29.65	29.69	—.19	30.2	+ 4.0	36.3	24.2	5.12	+0.19	19.5	Port Arthur, Ont	29.24	29.97	—.08	23.4	+ 6.6	33.3	13.4	0.66	—0.31	6.6
Halifax, N. S	29.59	29.70	—.24	31.6	+ 2.6	38.4	24.9	5.05	—0.41	14.9	Winnipeg, Man	29.20	30.07	—.02	17.1	+ 4.8	27.2	7.0	2.67	+1.64	26.7
Grand Manan, N. B	29.64	29.69	—.24	32.6	+ 2.8	39.0	26.3	4.41	+0.13	7.1	Minnedosa, Man	28.16	30.06	.00	16.9	+ 4.4	26.3	7.4	0.71	+0.06	7.1
Yarmouth, N. S	29.64	29.71	—.24	33.0	+ 2.2	38.4	27.5	5.27	+0.42	10.7	Qu' Appelle, Assin	27.66	29.99	—.05	18.8	+ 3.9	27.3	10.4	0.52	—0.25	5.2
Charlottetown, P. E. I	29.63	29.67	—.23	28.8	+ 3.4	34.5	23.2	4.09	+0.88	26.5	Medicine Hat, Alberta	27.66	29.98	—.02	32.4	+ 4.9	43.0	21.8	0.20	—0.56	2.0
Chatham, N. B	29.68	29.70	—.20	26.6	+ 3.6	33.8	19.4	4.47	+1.00	19.9	Swift Current, Sask	27.38	30.05	+.03	23.3	+ 1.3	30.4	16.1	0.36	—0.45	3.6
Father Point, Que	29.75	29.78	—.12	21.5	+ 1.2	28.5	14.6	2.90	+0.17	25.6	Calgary, Alberta	26.33	29.94	—.01	30.7	+ 4.5	41.8	19.6	0.68	—0.04	6.8
Quebec, Que	29.45	29.78	—.18	22.8	+ 1.6	30.1	15.5	3.29	+0.03	31.8	Banff, Alberta	25.26	29.96	+.02	27.6	+ 7.4	38.8	16.3	0.78	—0.63	7.8
Montreal, Que	29.57	29.79	—.21	25.8	+ 2.0	31.4	20.2	3.95	+0.16	22.9	Edmonton, Alberta	27.61	29.97	+.01	24.6	+ 0.4	35.3	13.8	0.11	—0.61	1.1
Rockliffe, Ont	29.22	29.83	—.18	20.4	+ 1.4	31.8	9.0	0.95	—1.11	9.1	Prince Albert, Sask	28.42	30.04	—.04	17.9	+ 5.9	28.1	7.7	0.55	—0.22	5.5
Ottawa, Ont	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Battleford, Sask	28.25	30.07	+.01	16.9	+ 3.8	26.1	7.8	0.02	—0.44	0.2
Kingston, Ont	29.53	29.85	—.16	27.2	+ 1.6	34.0	20.3	3.34	+0.70	14.5	Kamloops, B. C	28.60	29.89	—.03	43.4	+ 7.3	54.2	32.5	0.06	—0.51	0.0
Toronto, Ont	29.49	29.89	—.13	29.9	+ 2.6	36.3	23.4	2.77	+0.13	15.9	Victoria, B. C	29.90	30.00	+.03	43.6	+ 1.7	50.4	36.9	0.73	—2.39	0.0
White River, Ont	29.54	29.89	—.14	15.4	+ 3.2	30.3	0.5	1.00	—0.38	10.0	Barkerville, B. C	25.49	29.84	—.04	28.0	+ 1.9	37.5	18.6	1.40	—0.49	0.0
Port Stanley, Ont	29.24	29.90	—.13	30.4	+ 3.2	36.7	24.1	2.66	—0.22	9.7	Hamilton, Bermuda	29.82	29.99	—.09	61.9	— 0.3	66.8	57.0	4.94	—0.19	0.0
Southampton, Ont	29.15	29.88	—.15	28.6	+ 3.9	34.9	22.3	1.87	—0.78	15.9	Dawson, Yukon	28.61	.....	.....	12.0	.....	21.0	3.1	1.21	.....	12.1

TABLE IV.—*Heights of rivers referred to zeros of gages, March, 1909.*

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.	Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.						Height.	Date.	Height.	Date.		
Republican River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*	*Holston River.*	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Clay Center, Kans	42	18	7.5	1	6.6	15-22	6.9	0.9	Rogersville, Tenn	108	14	8.6	29	3.4	3,4	4.7	5.2
Smoky Hill-Kansas River.									*French Broad River.*								
Abilene, Kans	254	22	1.2	5	0.6	15, 24, 30	0.8	0.6	Asheville, N. C	144	4	2.8	26	0.8	5,24	1.5	2.0
Manhattan, Kans	160	18	4.8	25	3.1	19	3.8	1.7	Dandridge, Tenn	46	12	10.0	29	2.9	3	4.5	7.1
Topeka, Kans	87	21	8.9	26	6.2	19-22	6.8	2.7	*Tennessee River.*								
Missouri River.									Knoxville, Tenn	635	12	12.0	29	3.3	6	6.1	8.7
Bismarck, N. Dak	1,309	14	8.9	10, 11	5.2	1	7.8	3.7	Loudon, Tenn	590	25	11.2	11	3.2	6	6.5	8.0
Pierre, S. Dak. (4)	1,114	14	6.3	7	2.7	29	3.6	3.6	Kingston, Tenn	556	25	12.9	12	5.4	5,6	8.8	7.5
Sioux City, Iowa	784	17	14.0	7	7.4	17, 18	9.1	6.6	Chattanooga, Tenn	452	33	24.6	15	7.7	6	14.3	16.9
Blair, Nebr	705	15	12.7	8	6.9	3-5	9.4	5.8	Bridgeport, Ala	402	24	19.4	15	6.6	6	11.6	12.8
Omaha, Nebr	669	18	15.8	8	9.7	5	12.1	6.1	Guntersville, Ala	349	31	30.4	14	11.5	6	19.3	18.9
Plattsmouth, Nebr	641	17	9.0	9	5.1	4,5	6.4	5.9	Florence, Ala	255	16	19.6	15	8.0	7,8	12.3	11.6
St. Joseph, Mo	481	10	10.1	10	2.8	1	6.4	7.3	Riverton, Ala	225	32	39.3	17	19.8	8,9	27.8	19.5
Kansas City, Mo	388	21	17.6	10	8.8	1,2	13.1	8.8	Johnsonville, Tenn	95	25	32.9	1	14.8	29	23.8	18.1
Glasgow, Mo	231	21	17.6	11	8.9	3	13.6	8.7	*Ohio River.*								
Boonville, Mo	199	20	17.8	12	10.3	1	13.7	7.5	Pittsburg, Pa	966	22	12.5	5	3.1	25	7.6	9.4
Hermann, Mo	103	24	16.6	12	9.0	5,6	12.1	7.6	Coraopolis, Pa	956	25	13.0	4	5.0	25	8.5	8.0
Minnesota River.									Beaver Dam, Pa	937	27	19.4	5	7.8	25	12.9	11.6
Mankato, Minn	127	18	17.2	29, 30	3.0	1,2	7.9	14.2	Wheeling, W. Va	875	36	19.9	5	7.2	25	12.9	12.7
St. Croix River.									Parkersburg, W. Va	785	36	27.6	1	9.0	24-26	15.2	18.6
Stillwater, Minn. (3)	23	11	.....	.....	.....	.....	.....	.....	Point Pleasant, W. Va	703	39	38.8	1	10.1	22	19.8	28.7
Illinois River.									Huntington, W. Va	660	50	44.5	1	13.9	23	25.2	30.6
La Salle, Ill	197	18	20.8	1	16.9	26, 31	18.5	3.9	Catlettsburg, Ky	651	50	46.2	1	13.8	23	26.1	32.4
Peoria, Ill	185	14	16.0	3	13.5	29-31	14.8	2.5	Portsmouth, Ohio	612	50	49.8	1	14.0	24	27.6	35.8
Conemaugh River.									Maysville, Ky	559	50	49.9	1	15.0	24	28.3	34.9
Johnstown, Pa	64	7	5.7	4	2.4	22-26	3.2	3.3	Cincinnati, Ohio	499	50	54.1	1	17.2	25	31.8	36.9
Allegheny River.									Madison, Ind	413	46	47.0	1	15.4	26	28.6	31.6
Warren, Pa	177	14	6.4	11	1.4	20	3.4	5.0	Louisville, Ky	367	28	31.7	1	7.6	26	15.0	24.1
Parker, Pa	73	20	8.0	12	2.4	24	4.7	5.6	Evansville, Ind	184	35	43.2	2	15.1	29,30	33.0	28.1
Freeport, Pa	29	20	12.5	4, 12	5.2	25	8.9	7.3	Mount Vernon, Ind	148	35	43.2	3-5	14.4	30	33.9	28.8
Springdale, Pa	17	27	17.4	4, 12	10.5	25	13.9	6.9	Paducah, Ky	47	40	44.5	5,6	22.1	31	38.5	22.4
Youghiogheny River.									Cairo, Ill	1	45	47.3	17	31.4	31	43.7	15.9
Confluence, Pa	59	10	4.3	4	1.2	25	2.3	3.1	*Neosho River.*								
West Newton, Pa	15	23	7.2	4	1.5	25	3.1	5.7	Iola, Kans	262	10	6.1	21	— 0.7	8	0.9	6.8
Monongahela River.									Oswego, Kans	184	20	15.4	22	0.9	8	3.3	14.5
Fairmont, W. Va	119	25	19.3	4	14.8	25	16.1	4.5	Fort Gibson, Okla	3	22	16.5	23	10.5	8-13	12.1	6.0
Greensboro, Pa	81	18	12.8	4	7.5	25	9.3	5.3	*Canadian River.*								
Lock No. 4, Pa	40	28	16.4	5	8.8	19	11.4	7.6	Calvin, Okla	99	15	3.1	13, 25	2.6	2-7	2.8	0.5
Muskingum River.									*Black River.*								
Zanesville, Ohio	70	25	19.0	1	9.8	24	13.2	9.2	Blackrock, Ark	67	12	24.7	11	13.1	8	18.2	11.6
Little Kanawha River.									*White River.*								
Creston, W. Va	38	20	7.8	4	2.6	23-25	4.0	5.2	Calicorock, Ark	272	18	19.4	10	3.1	8,31	6.1	16.3
New-Great Kanawha River.									Batesville, Ark	217	18	22.1	10	5.0	8	8.6	17.1
Hinton, W. Va	153	14	5.8	26	3.0	21, 22	4.2	2.8	Newport, Ark	185	26	26.0	14	13.8	8	19.8	12.2
Charleston, W. Va	58	30	12.0	11	4.6	21	8.0	7.4	Clarendon, Ark	75	30	28.9	21, 22	26.0	1	28.0	2.9
Scioto River.									*Arkansas River.*								
Columbus, Ohio	110	17	7.6	10	1.8	21-24	3.9	5.8	Wichita, Kans	832	10	— 0.8	1-3	— 1.4	21	1.1	0.6
Licking River.									Tulsa, Okla	551	16	6.8	21	2.4	4-11	3.1	4.4
Falmouth, Ky	30	25	26.0	9	2.2	29	6.2	23.8	Webbers Falls, Okla	465	23	13.4	24	5.3	8	8.0	8.1
Kentucky River.									Fort Smith, Ark	403	22	12.7	24	5.8	7,8	8.1	6.9
Beattyville, Ky	254	30	21.9	10	1.4	24	5.0	20.5	Dardanelle, Ark	256	21	12.5	26	5.8	8	8.2	6.7
Frankfort, Ky	65	31	25.0	10	7.1	23, 24	10.3	17.9	Little Rock, Ark	176	23	13.5	11	6.0	24	9.1	6.8
Wabash River.									Pine Bluff, Ark	121	25	17.9	12	10.9	25	14.1	7.0
Terre Haute, Ind	171	16	17.8	1	3.9	24-27	7.7	13.9	*Yazoo River.*								
Mount Carmel, Ill	75	15	19.7	4	5.7	28	13.6	14.0	Greenwood, Miss	175	38	30.2	25-29	23.3	1	27.4	6.9
Cumberland River.									Yazoo City, Miss	80	25	25.7	31	19.2	1	22.7	6.5
Burnside, Ky	518	50	33.3	11	4.7	5	13.4	28.6	*Ouachita River.*								
Celina, Tenn	383	45	32.1	12	8.0	5	18.5	24.1	Camden, Ark	304	39	29.7	14	9.2	31	17.4	20.5
Carthage, Tenn	308	40	32.8	1	7.0	6	18.5	25.8	Monroe, La	122	40	30.5	29	25.9	1	27.9	4.6
Nashville, Tenn	193	40	39.8	1	14.4	6	25.4	25.4	*Red River.*								
Clarksville, Tenn	126	43	44.6	1	22.0	8	30.4	22.6	Arthur City, Tex	688	27	7.7	26	6.1	6-8,19	6.6	1.6
Clinch River.									Fulton, Ark	515	28	17.8	14	9.2	8	12.3	8.6
Speers Ferry, Va	156	20	11.0	11	1.6	22, 23, 25	3.6	9.4	Shreveport, La	327	29	9.0	16	2.3	9,10	5.1	6.7
Clinton, Tenn	52	25	18.4	12	7.5	5	11.6	10.9	Alexandria, La	118	36	17.2	19	7.8	12	12.1	9.4
South Fork Holston River.									*Mississippi River.*								
Bluff City, Tenn	35	12	5.4	29	2.0	24	3.1	3.4	Fort Ripley, Minn. (5)	2,082	10	.....	.....	.....	.....	.....	.....
									St. Paul, Minn. (15)	1,964	14	9.6	31	4.3	22	6.2	5.

TABLE IV.—*Heights of rivers referred to zeros of gages*—Continued.

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River.—Cont'd.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Red Wing, Minn. (32)	1,914	14	.....	.....	.....	.....	.....	.....
Reeds Landing, Minn.	1,884	12	4.4	31	— 0.5	6	1.3	4.9
La Crosse, Wis. (31)	1,819	12	.....	.....	.....	.....	.....	.....
Prairie du Chien, Wis. (31)	1,759	18	.....	.....	.....	.....	.....	.....
Dubuque, Iowa (31)	1,699	18	.....	.....	.....	.....	.....	.....
Clinton, Iowa	1,629	16	6.2	31	3.0	17-19	4.5	3.2
Leclaire, Iowa ‡	1,609	10	3.6	31	1.2	17,18	2.4	2.4
Davenport, Iowa	1,593	15	6.1	1	3.4	18	4.9	2.7
Muscatine, Iowa	1,562	16	8.5	1	4.5	19,20	6.2	4.0
Galland, Iowa	1,472	8	4.2	13	2.4	20	3.4	1.8
Keokuk, Iowa	1,463	15	7.5	31	4.3	21,22	6.2	3.2
Warsaw, Ill.	1,458	18	10.9	31	7.2	21	9.2	3.7
Hannibal, Mo.	1,402	13	9.0	12,13	5.5	22,23	7.6	3.5
Grafton, Ill	1,306	23	12.7	13,14	8.7	23,24	10.6	4.0
St. Louis, Mo.	1,264	30	22.6	13	13.3	7	16.4	9.3
Chester, Ill.	1,189	30	20.0	14	11.7	8	14.6	8.3
Cape Girardeau, Mo.	1,128	28	25.8	14	17.4	27	20.4	8.4
New Madrid, Mo.	1,003	34	38.6	18	26.4	31	36.0	12.2
Memphis, Tenn	843	33	38.6	22	30.5	31	36.5	8.1
Helena, Ark.	767	42	47.7	25	38.0	1	44.9	9.7
Arkansas City, Ark.	635	42	50.1	28-30	38.9	1	46.3	11.2
Greenville, Miss.	595	42	44.8	29,30	32.9	1	40.4	11.9
Vicksburg, Miss.	474	45	47.9	30,31	36.2	1	43.6	11.7
Natchez, Miss.	373	46	47.7	30,31	35.3	1	42.5	12.4
Baton Rouge, La.	240	35	35.6	31	25.3	1	30.9	10.3
Donaldsonville, La	188	28	28.3	31	19.3	1	24.2	9.0
New Orleans, La.	108	18	17.6	31	11.7	1	15.2	5.9
Atchafalaya River.								
Simmesport, La.	127	41	38.6	31	28.8	1	33.6	7.8
Melville, La.	108	37	35.4	31	29.3	1	32.4	6.1
Morgan City, La.	19	8	4.0	9,24	2.3	15	3.3	1.7
Hudson River.								
Troy, N. Y.	154	14	8.9	1	4.3	20	5.7	4.6
Albany, N. Y.	147	12	7.4	26	1.7	8	4.2	5.7
Delaware River.								
Hancock (E. Branch), N. Y.	287	12	6.4	26	3.6	23,24	4.4	2.8
Hancock (W. Branch), N. Y.	287	10	6.9	11	3.4	24	4.5	3.5
Port Jervis, N. Y.	215	14	7.5	26	3.0	24	4.7	4.5
Phillipsburg, N. J.	146	26	8.2	27	2.8	24,25	4.8	5.4
Trenton, N. J.	92	18	5.0	1,28	2.3	23,24	3.6	2.7
North Branch Susquehanna.								
Binghamton, N. Y.	183	14	7.6	11,26,27	3.1	23-25	4.7	4.5
Wilkes-Barre, Pa.	60	17	12.2	12	5.1	25	8.2	7.1
West Branch Susquehanna.								
Williamsport, Pa.	39	20	7.0	12	2.6	24,25	4.6	4.4
Susquehanna River.								
Harrisburg, Pa.	69	17	7.6	1	3.0	24-26	4.8	4.6
Shenandoah River.								
Riverton, Va.	58	22	0.8	1,17	— 0.3	26,27	0.2	1.1
Potomac River.								
Cumberland, Md.	290	8	4.5	4	2.8	25-28	3.5	1.7
Harpers Ferry, W. Va.	172	18	5.0	1	1.0	27,28	3.0	4.0
James River.								
Lynchburg, Va.	260	20	5.4	26	1.5	21	2.9	3.9
Columbia, Va.	167	18	10.1	27	6.2	19-21	7.5	3.9
Richmond, Va.	111	10	3.4	28	0.8	21	1.7	2.6
Dan River.								
Danville, Va	55	8	2.6	26	0.1	24	0.7	2.5
Roanoke River.								
Clarksville, Va	196	12	3.5	27	0.8	23	1.8	2.7
Weldon, N. C.	129	30	17.5	28	11.6	21-23	13.7	5.9
Tar River.								
Greenville, N. C.	21	22	11.3	1	5.4	20,24,25	7.0	5.9
Haw River.								
Moncure, N. C.	171	25	10.5	29	8.1	20,22	8.6	2.4
Cape Fear River.								
Fayetteville, N. C.	112	38	12.8	1	5.9	20,21	8.2	6.9
Pedee River.								
Cheraw, S. C.	149	27	12.3	28	3.9	21	6.5	8.4
Smiths Mills, S. C.	51	16	12.3	5	7.6	29	10.4	4.7
Lynch Creek.								
Effingham, S. C.	35	12	9.0	1,5,6, 18,19	6.5	24,25,31	7.8	2.5
Black River.								
Kingstree, S. C.	45	12	6.3	1,2	5.0	13,14	5.7	1.3
Catawba-Wateree River.								
Mount Holly, N. C.	143	15	3.0	14,28	2.0	*	2.2	1.0

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Catawba-Wateree River—Con	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Catawba, S. C.	107	11	7.4	27	3.0	20	4.3	4.4
Camden, S. C.	37	24	17.8	11	8.8	8	11.9	9.0
Congaree River.								
Columbia, S. C.	52	15	9.4	11	2.5	7	4.2	6.9
Santee River.								
Ferguson, S. C.	82	12	13.6	17-20	12.5	9-12,28-30	13.0	1.1
Savannah River.								
Calhoun Falls, S. C.	347	15	7.3	14	2.9	31	4.0	4.4
Augusta, Ga.	268	32	28.0	15	10.8	7	16.2	17.2
Oconee River.								
Dublin, Ga	79	30	23.3	16	4.3	8	12.1	19.0
Ocmulgee River.								
Macon, Ga.	134	18	20.6	13	5.3	6	10.9	15.3
Abbeville, Ga.	51	11	16.7	19	7.5	10	11.9	9.2
Flint River.								
Montezuma, Ga.	152	20	18.7	16	6.1	7	11.6	12.6
Albany, Ga.	99	20	22.4	20	3.7	9	13.3	18.7
Bainbridge, Ga.	22	22	22.1	26	8.1	8,9	14.8	14.0
Chattahoochee River.								
Oakdale, Ga.	305	21	24.7	15	8.1	6	12.2	16.6
West Point, Ga	174	20	19.2	13	4.3	6	8.8	14.9
Eufaula, Ala	90	40	41.8	15	6.0	6,7	18.2	35.8
Alaga, Ala.	30	25	33.3	16	8.3	7	19.4	27.0
Coosa River.								
Rome, Ga.	266	30	31.5	14	4.7	6	13.9	26.8
Gadsden, Ala.	162	22	27.4	17	7.2	6	17.1	20.2
Lock No. 4, Ala.	113	17	22.7	14	6.4	6,7	14.0	16.3
Wetumpka, Ala	12	45	51.3	15	11.9	7	32.2	39.4
Alabama River.								
Montgomery, Ala.	323	35	51.7	15	9.0	8	31.7	42.7
Selma, Ala	246	35	52.9	18	11.8	8	37.0	41.1
Black Warrior River.								
Tuscaloosa, Ala.	90	43	61.3	14	16.5	7	35.7	44.8
Tombigbee River.								
Columbus, Miss.	316	33	28.4	15	3.5	31	16.1	24.9
Demopolis, Ala.	168	35	61.5	21	41.9	9	51.7	19.6
Pascagoula River.								
Merrill, Miss.	78	20	19.8	17-19	3.2	9	12.2	16.6
Pearl River.								
Columbia, Miss.	110	18	16.1	29,30	11.7	11	14.1	4.4
Sabine River.								
Logansport, La.	315	25	17.6	16	4.8	7,8	9.2	12.8
Neches River.								
Beaumont, Tex†	18	10	1.5	8	0.1	14	0.9	1.4
Trinity River.								
Dallas, Tex.	320	25	10.7	1	4.1	8,26	5.1	6.6
Long Lake, Tex.	211	40	10.0	15	3.3	8	5.7	6.7
Liberty, Tex	20	25	6.9	21,22	4.9	11	5.7	2.0
Brazos River.								
Waco, Tex.	285	24	2.6	10	1.1	4-6	1.4	1.5
Hempstead, Tex	140	40	1.3	14	0.0	*	0.3	1.3
Booth, Tex	61	39	2.7	15-31	2.5	1-7	2.6	0.2
Colorado River.								
Austin, Tex.	214	18	1.2	9,10,13,26	0.9	*	1.0	0.3
Columbus, Tex.	98	24	5.7	1-4	5.5	12-14,27-31	5.6	0.2
Red River of the North.								
Moorhead, Minn. (18)	284	26	.....	.....	.....	.....	.....	.....
Snake River.								
Lewiston, Idaho	144	24	6.0	31	3.3	14	4.2	2.7
Columbia River.								
Wenatchee, Wash	473	40	7.5	29-31	6.8	*	7.1	0.7
Umatilla, Oreg	270	25	4.2	31	2.5	16	3.2	1.7
The Dalles, Oreg.	166	40	7.0	31	3.5	27	5.1	3.5
Willamette River.								
Albany, Oreg.	118	20	10.7	3	3.9	27,28	6.3	6.8
Portland, Oreg.	12	15	7.8	4	3.0	27	5.1	4.8
Sacramento River.								
Red Bluff, Cal.	265	23	12.8	5	6.8	26,27	8.4	6.0
Colusa, Cal.	156	28	20.9	8	15.5	28,29	17.7	5.4
Knights Landing, Cal.	99	18	17.5	1	15.4	29	16.5	2.1
Sacramento, Cal.	64	25	20.9	1	18.6	28-30	19.8	2.3
San Joaquin River.								
Pollasky, Cal.	203	10	1.7	4	0.9	1-3,29-31	1.2	0.8
Firebaugh, Cal.	148	14	5.5	6	3.2	30	4.2	2.3
Lathrop, Cal.	49	14	14.7	1	9.8	30	12.2	4.9

* Various dates. † 7 days missing. ‡ 4 days missing. Figures in parenthesis indicate number of days river was frozen during the month.

Honolulu, T. H., latitude 21° 19′ north, longitude 157° 52′ west; barometer above sea, 38 feet; gravity correction, —0.057 inch, applied. March, 1909.

Day.	Pressure, in inches.*		Air temperature, degrees Fahrenheit.				Moisture.				Wind, in miles per hour.				Precipitation, inches.		Clouds.					
							8 a. m.		8 p. m.		8 a. m.		8 p. m.				8 a. m.			8 p. m.		
	8 a. m.	8 p. m.	8 a. m.	8 p. m.	Maximum.	Minimum.	Wet.	Relative humidity.	Wet.	Relative humidity.	Direction.	Velocity.	Direction.	Velocity.	8 a. m.	8 p. m.	Amount.	Kind.	Direction, from.	Amount.	Kind.	Direction, from.
							°	%	°	%												
1	30.09	30.07	68.0	66.0	71	60	62.0	71	62.0	80	e.	20	ne.	10	0.02	0.12	9	S.-cu.	e.	5	Cu.	ne.
																				1	N.	ne.
2	30.07	30.07	68.1	68.0	73	62	62.2	72	63.5	78	e.	3	e.	10	0.29	0.11	8	S.-cu.	e.	10	Cu.	ne.
3	30.11	30.13	70.2	69.0	75	63	63.3	68	64.0	76	ne.	15	e.	15	0.25	T.	4	Cu.	e.	3	Cu.	ne.
																				1	Cu.-n.	ne.
4	30.13	30.10	70.0	67.5	74	64	66.0	81	62.5	76	ne.	18	ne.	15	0.01	0.02	8	Ci.-s.	w.	5	Cu.	ne.
																	2	S.-cu.	e.	1	N.	ne.
5	30.09	30.06	71.0	69.0	76	68	62.0	60	64.0	76	e.	8	ne.	2	T.	0.00	Few	Ci.-cu.	0	3	Cu.	ne.
																	4	Cu.	e.			
6	30.05	30.03	69.3	71.0	76	67	63.4	72	66.0	77	ne.	14	e.	15	0.01	T.	4	Ci.-s.	ne.	3	Cu.	ne.
7	30.02	29.96	72.8	70.5	77	68	64.7	73	64.5	72	e.	6	sw.	3	0.00	0.00	1	Cu.	e.	Few	Cu.	ne.
8	29.95	29.91	70.4	71.5	75	64	65.1	75	67.0	79	n.	1	sw.	3	0.00	0.00	2	Cu.	0(?)	1	Cu.	ne.
9	29.89	29.92	71.6	67.0	76	66	66.0	74	64.0	85	sw.	13	n.	10	0.00	0.07	5	Cu.	sw.	10	S.	n.
10	30.04	30.03	67.3	66.0	72	63	62.3	75	62.5	82	ne.	16	ne.	21	0.02	T.	9	S.-cu.	0	1	S.	ne.
11	30.04	30.06	68.0	68.5	70	65	64.0	80	65.0	83	ne.	27	ne.	9	T.	0.03	10	A.-s.	sw.	10	N.	ne.
12	30.06	29.99	63.8	68.0	72	60	62.0	91	67.0	95	sw.	6	e.	5	0.49	0.40	5	S.	0	10	N.	n.
																	5	N.	ne.			
13	29.97	29.90	69.0	70.5	72	66	66.0	85	65.0	74	ne.	2	e.	10	0.06	0.13	10	A.-s.	sw.	10	S.	n.
14	29.89	29.91	72.0	68.0	73	67	67.0	77	66.0	90	se.	7	e.	8	0.04	0.21	10	A.-s.	se.	10	S.	e.
15	30.01	30.00	71.0	72.5	76	67	67.2	87	66.0	71	ne.	5	ne.	9	0.08	T.	10	A.-s.	sw.	10	S.	ne.
16	30.06	30.07	73.7	71.0	77	70	66.0	66	63.5	66	ne.	14	ne.	3	T.	T.	6	Ci.-s.	0	0	0	0
																	4	Cu.	e.			
17	30.08	30.10	71.5	71.0	76	66	65.0	70	64.0	68	ne.	10	ne.	17	T.	T.	5	A.-cu.	0	3	Cu.	e.
																	5	N.	e.			
18	30.12	30.12	70.6	70.0	74	66	63.0	66	63.0	68	ne.	16	e.	18	T.	T.	4	A.-s.	0	0	0	0
																	6	Cu.	e.			
19	30.13	30.11	68.0	71.0	74	64	62.1	72	63.0	64	ne.	19	ne.	22	0.02	0.02	3	Ci.-s.	0	0	0	0
																	6	S.-cu.	e.			
20	30.15	30.13	71.2	71.0	76	65	62.4	61	64.0	68	e.	18	e.	7	0.00	0.00	9	Ci.	w.	0	0	0
																	1	S.-cu.	e.			
21	30.14	30.13	72.0	69.3	78	67	65.0	69	64.0	75	ne.	4	ne.	14	T.	0.04	9	Ci.-s.	w.	1	A.-s.	0(?)
																	1	Cu.-n.	0	2	Cu.-n.	e.
22	30.16	30.15	70.5	70.0	75	64	62.2	62	62.0	64	ne.	10	ne.	10	0.16	0.03	3	Cu.	e.	3	A.-s.	w.
																	5	Cu.-n.	e.			
23	30.20	30.19	71.4	71.0	76	66	62.2	60	63.0	64	e.	13	e.	20	T.	0.00	7	S.-cu.	e.	2	Cu.	ne.
24	30.21	30.18	72.0	69.5	75	64	62.5	59	62.0	66	ne.	9	ne.	5	T.	0.00	8	S.-cu.	ne.	2	Cu.	ne.
25	30.21	30.18	67.0	67.0	74	62	60.0	66	61.5	73	ne.	10	ne.	8	0.16	0.03	9	S.-cu.	ne.	6	Cu.	ne.
26	30.21	30.19	69.1	69.0	72	64	61.0	63	62.0	67	ne.	8	ne.	12	0.35	0.01	9	S.-cu.	ne.	10	Cu.	ne.
27	30.22	30.18	69.0	68.0	73	65	61.1	63	62.0	71	ne.	16	e.	10	0.01	T.	1	Ci.-s.	0(?)	8	Cu.	e.
																	6	S.-cu.	e.			
28	30.17	30.11	68.1	65.5	73	63	61.5	69	63.0	87	ne.	4	ne.	4	0.01	0.02	9	S.-cu.	e.	5	N.	e.
																				4	Cu.	e.
29	30.11	30.07	67.0	70.0	74	65	63.3	82	64.0	72	ne.	8	e.	4	0.07	T.	9	S.-cu.	e.	9	Cu.	ne.
30	30.11	30.07	68.0	70.0	77	65	65.0	85	64.0	72	ne.	5	e.	5	0.05	T.	7	A.-s.	ne.	2	Cu.	ne.
																	2	N.	ne.			
31	30.08	30.04	70.3	70.0	75	66	64.0	71	64.0	72	sw.	4	ne.	12	T.	0.13	6	A.-s.	ne.	9	Cu.	ne.
Mean	30.089	30.070	69.7	69.2	74.4	64.9	63.5	71.8	63.8	74.5	ne.	10.6	ne.	10.2	2.10	1.37	7.9	S.-cu.	e.	5.2	Cu.	ne.

Observations are made at 8 a.m. and 8 p. m., local standard time, which is that of 157° 30′ west, and is 5h and 30m slower than 75th meridian time. *Pressure values are reduced to sea level and standard gravity.

RAINFALL IN JAMAICA.

Through the kindness of Mr. Maxwell Hall, meteorologist to the government of Jamaica and now in charge of the meteorological service of that island, we have received the following data:

Comparative table of rainfall.

[Based upon the average stations only.]

FEBRUARY, 1909.

Divisions.	Relative area.	Number of stations.	Rainfall.	
			1909.	Average.
Northeastern division	25	17	2.75	4.79
Northern division	22	41	0.77	2.55
West-central division	26	20	1.76	2.67
Southern division	27	26	1.24	1.89
Means	100		1.63	2.98

The rainfall over the island for February was therefore 1 inch below the average.

The greatest rainfall, 12.05 inches, was recorded at Shrewsbury, and a great many places in the northern and southern divisions had no rain during this month.

At Georgetown, Grand Cayman, 1.64 inches fell on four days. The greatest fall was 1.13 inches on the 21st.

MARCH, 1909.

Divisions.	Relative area.	Number of stations.	Rainfall.	
			1909.	Average.
Northeastern division	25	17	3.83	3.33
Northern division	22	41	2.36	2.11
West-central division	26	20	3.76	3.62
Southern division	27	26	1.52	2.13
Means	100		2.87	2.79

The rainfall over the island for March was therefore the average.

The greatest rainfall, 19.46 inches, was recorded at The Vinery; and no rain fell at Alligator Pond and Low River this month.

On the 6th an extraordinary rainfall occurred on a line between Buff Bay and Ocho Rios; the places affected between these extremes, were Vinery, Agualta Vale, Water Valley, Albany, Hampstead, and Gayle. At these places an average of 14 inches fell and did a great deal of damage to the road. The rain did not approach from the sea as is so usual in the northeast division, because the rainfall at Port Maria was much less than further inland, and the same thing occurred again at Buff Bay.

Chart I. Hydrographs for Seven Principal Rivers of the United States, March, 1909.

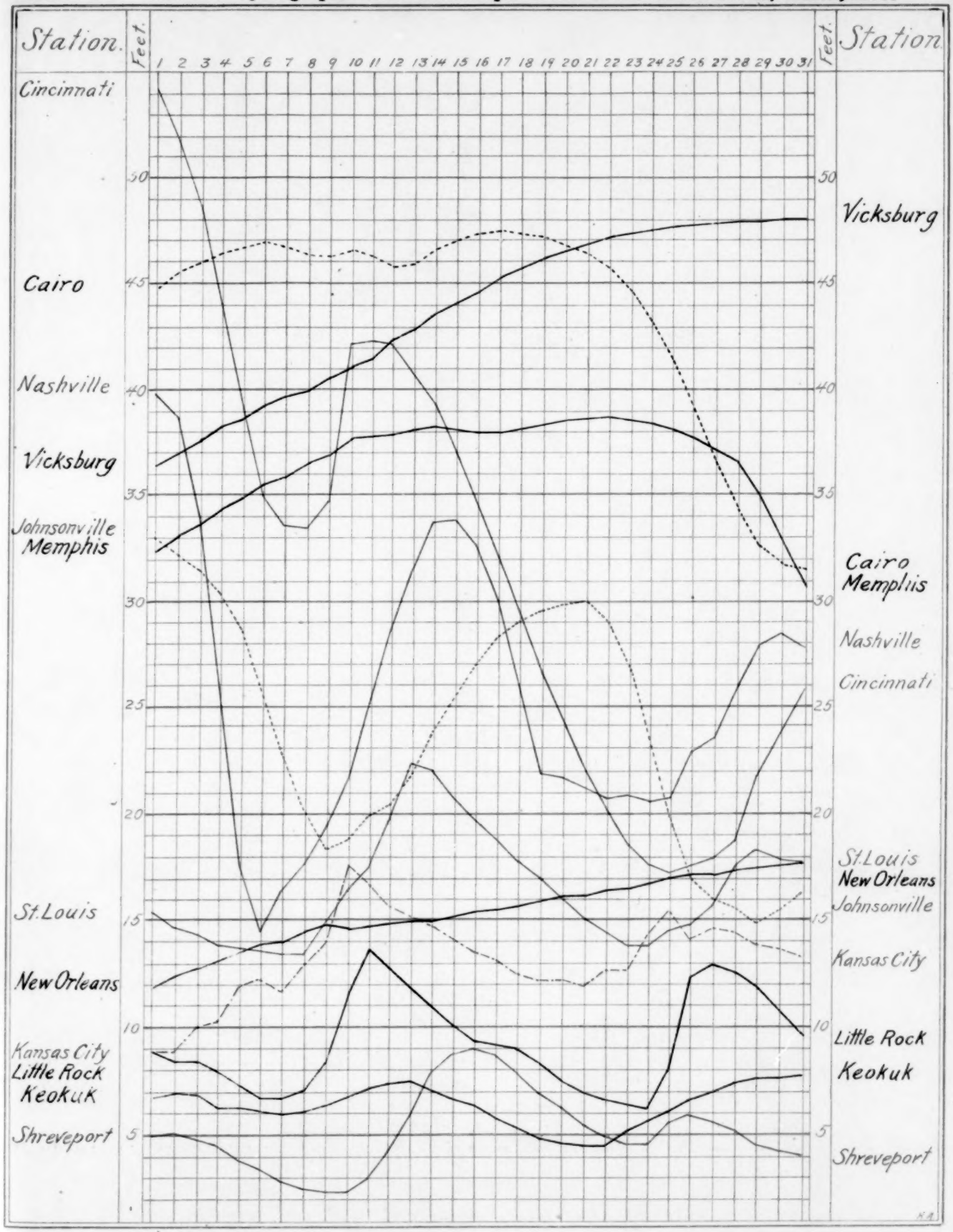


Chart II. Tracks of Centers of High Areas, March, 1909.

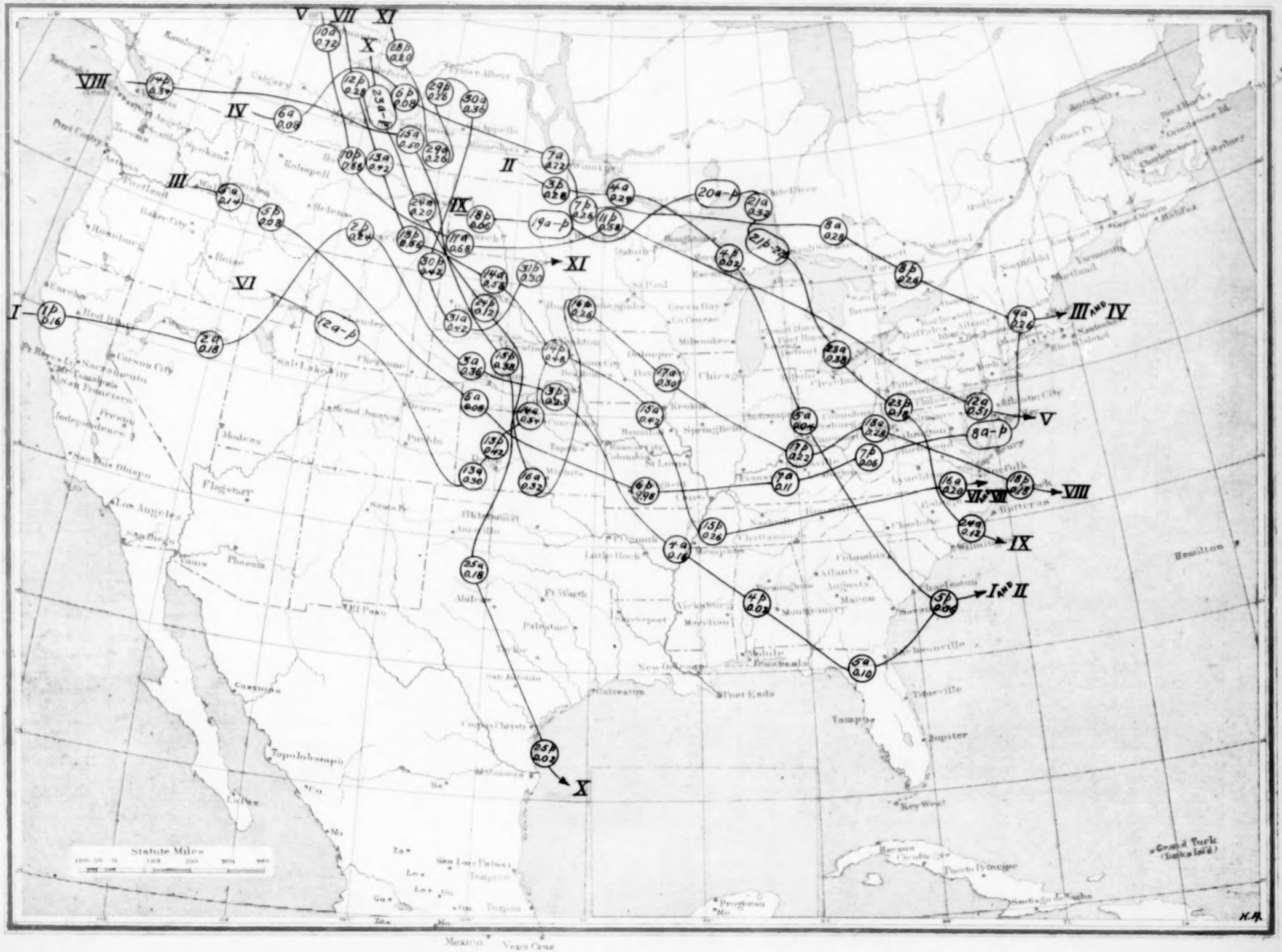


Chart III. Tracks of Centers of Low Areas, March, 1909.

Chart III. Tracks of Centers of Low Areas, March, 1909.

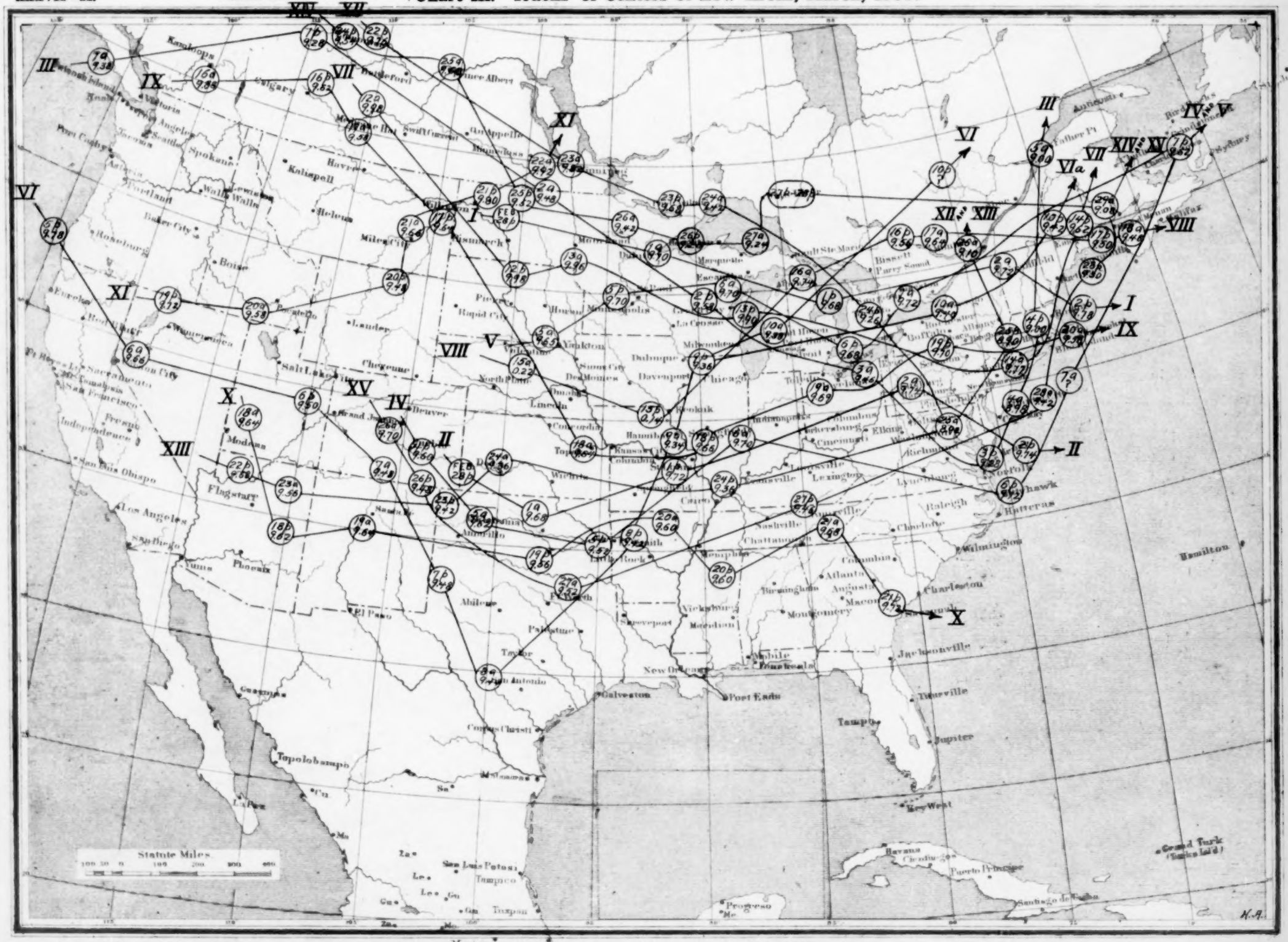
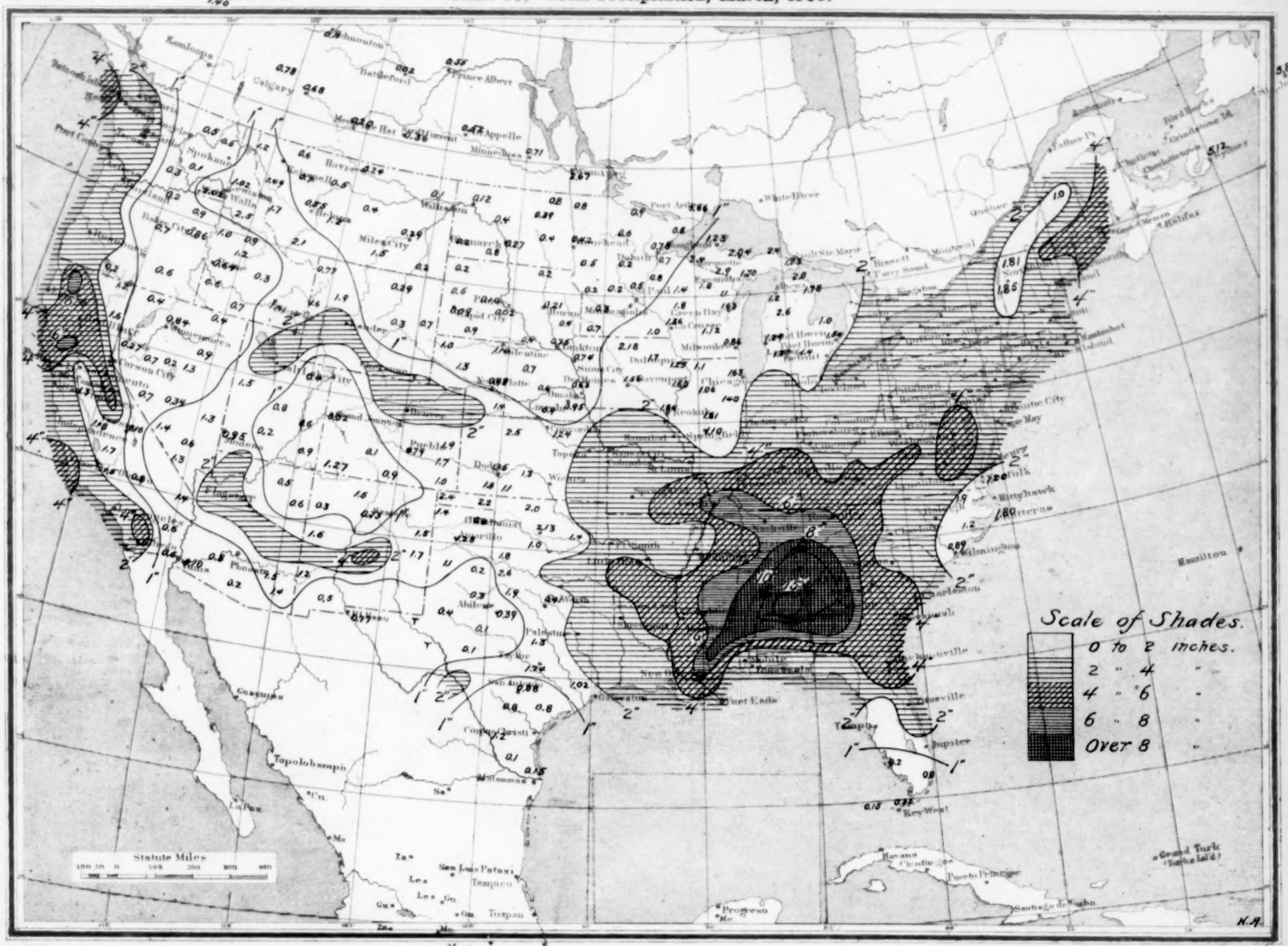


Chart IV. Total Precipitation, March, 1909.



• Barkerville **Chart V. Percentage of Clear Sky between Sunrise and Sunset, March, 1909.**

Chart V. Percentage of Clear Sky between Sunrise and Sunset, March, 1909.

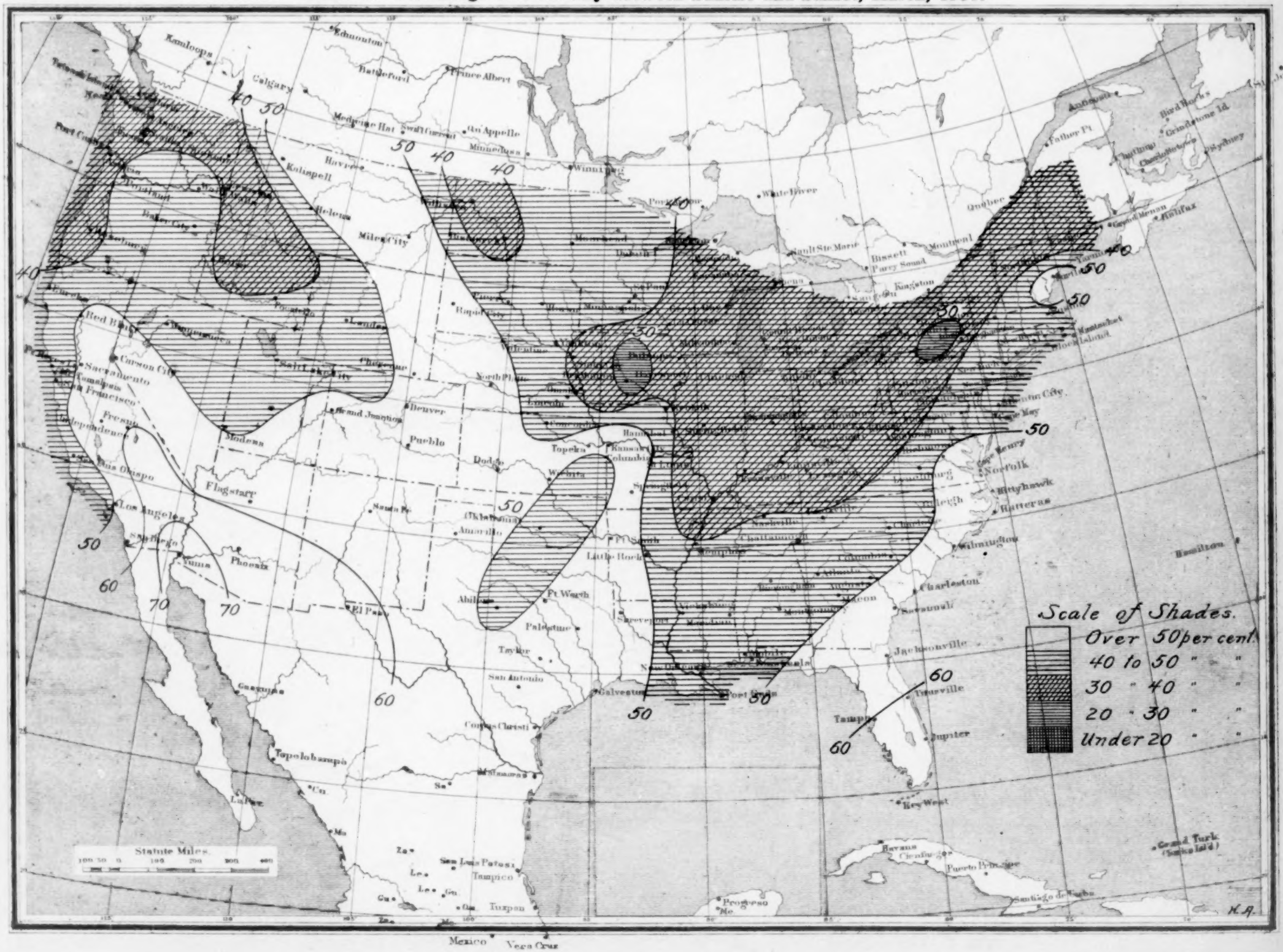


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Chart VI. Isobars and Isotherms at Sea Level; Prevailing Winds, March, 1909.

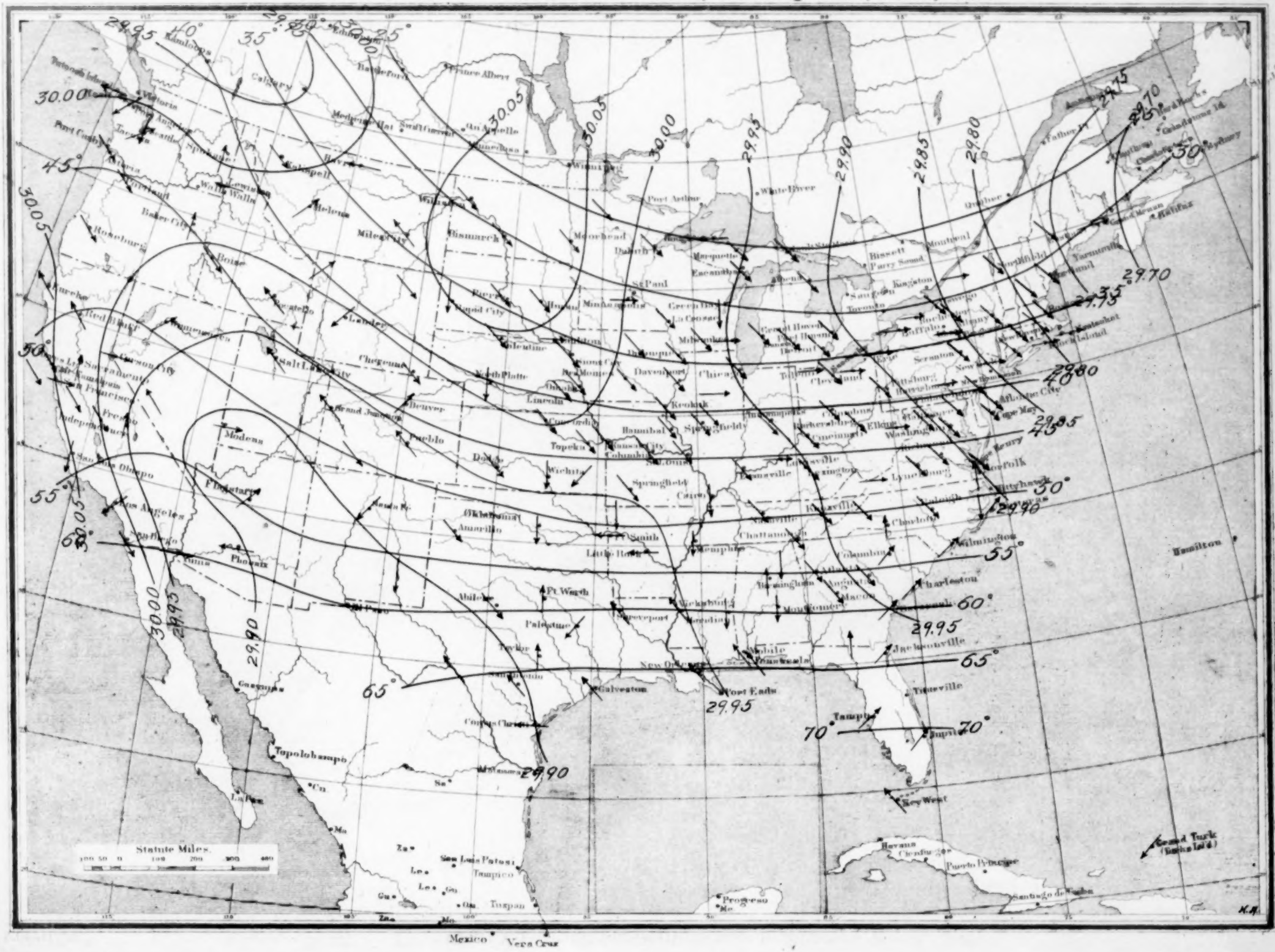

Chart VII. Total Snowfall for March, 1909.

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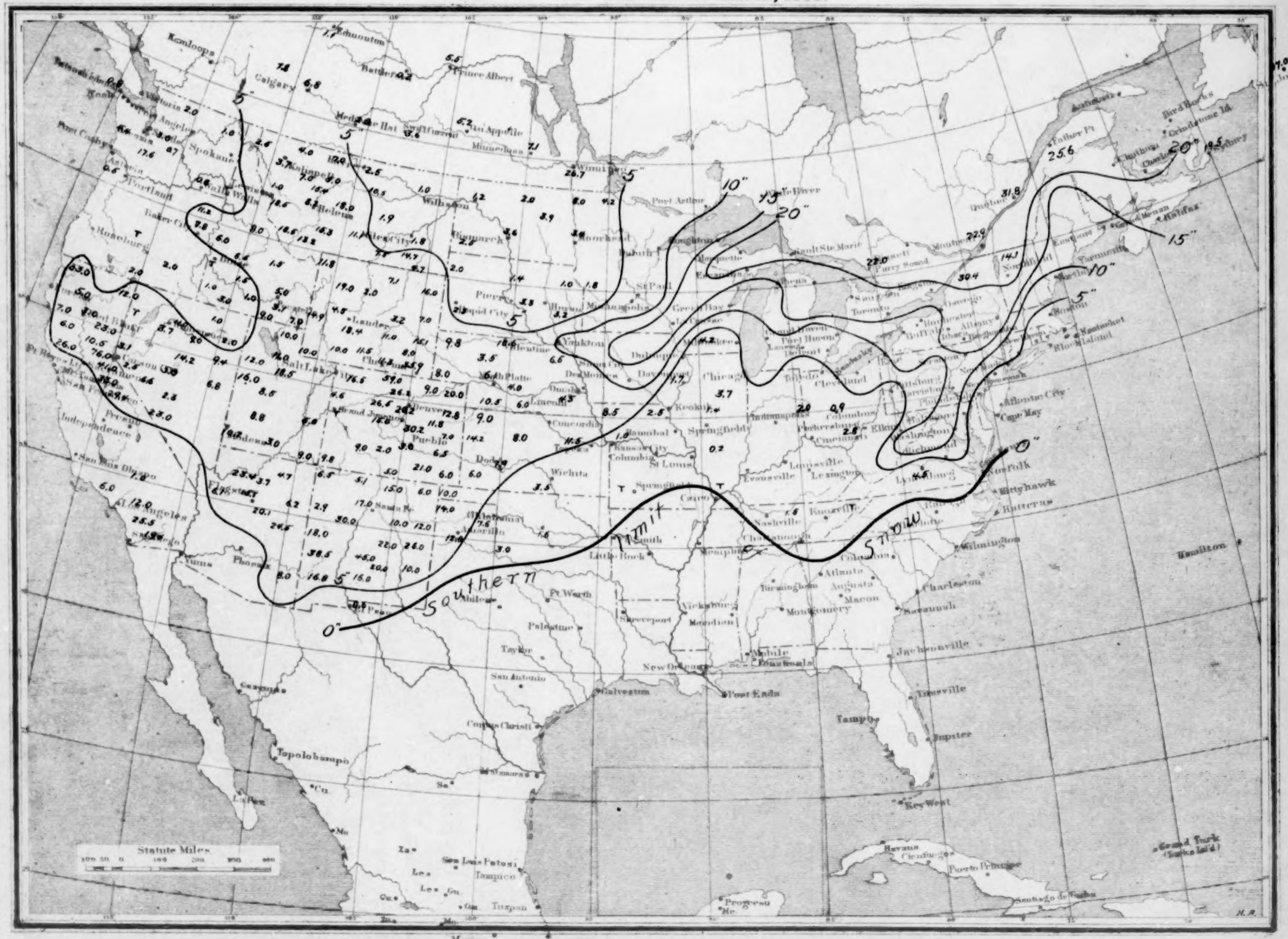


Chart VIII. Depth of Snow on Ground, March 31, 1909.

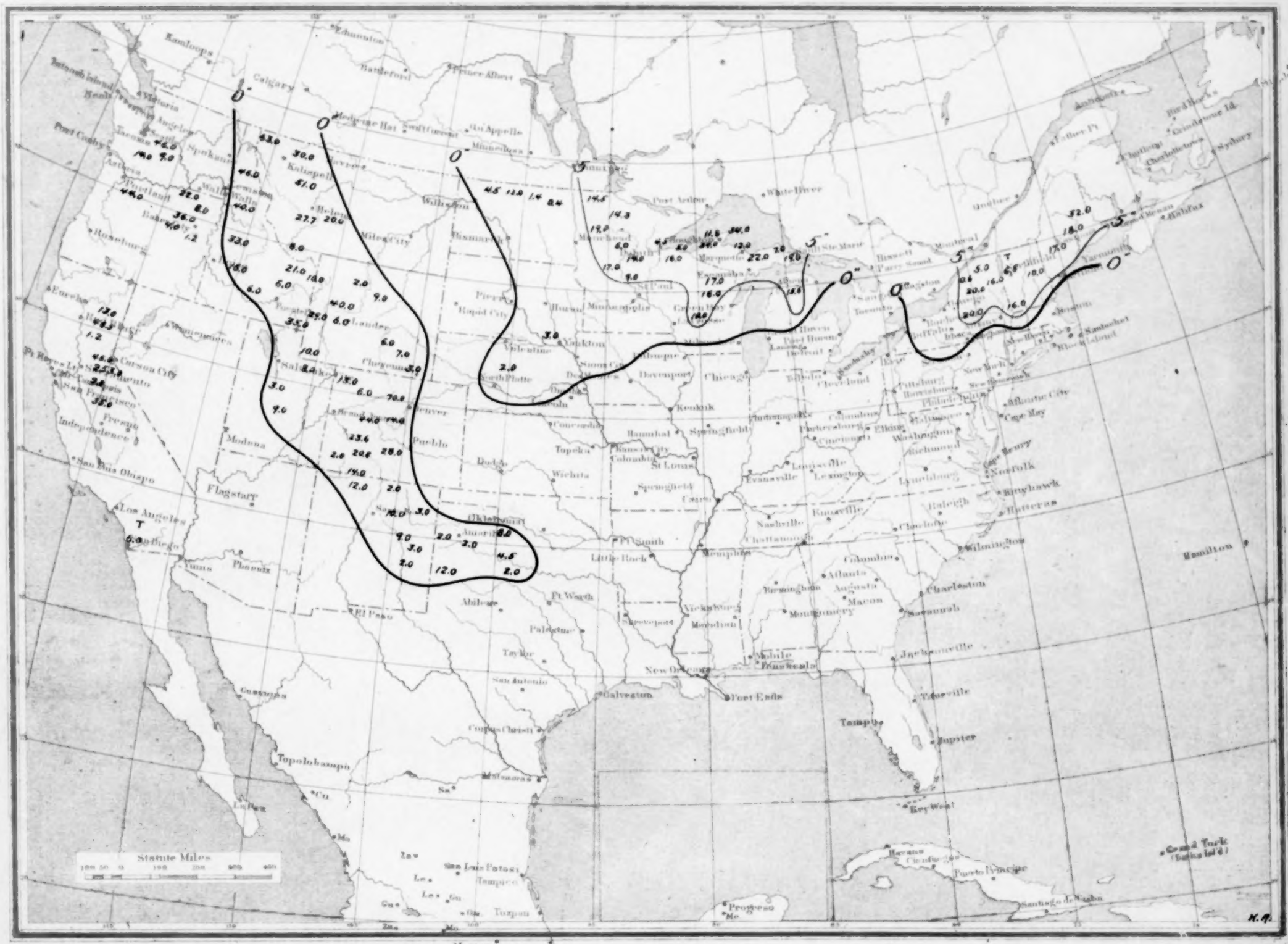
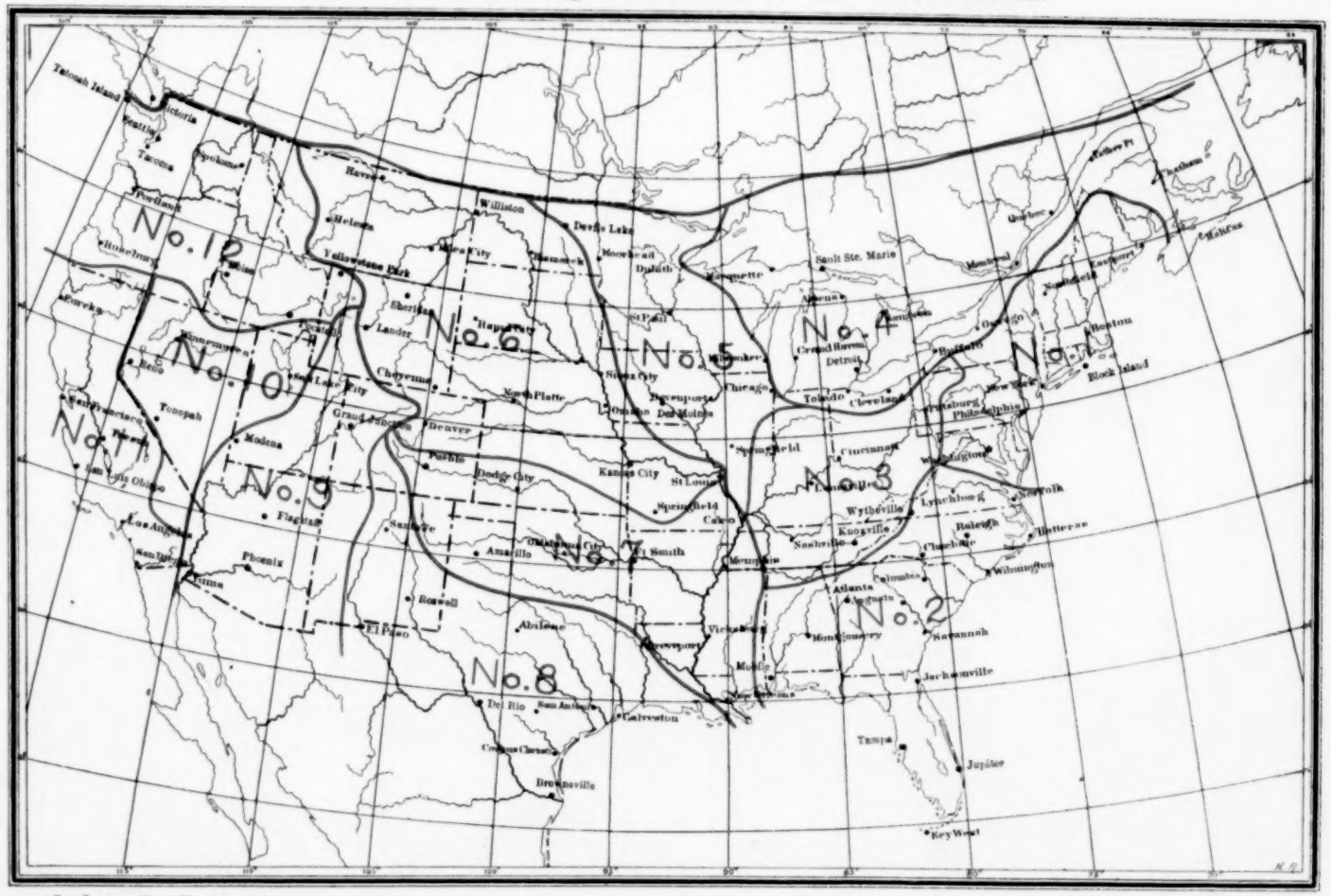


Chart IX. Climatological Districts of the United States.



See Instructions No. 60, 1909.